OCS EIS/EA
BOEM 2012-019

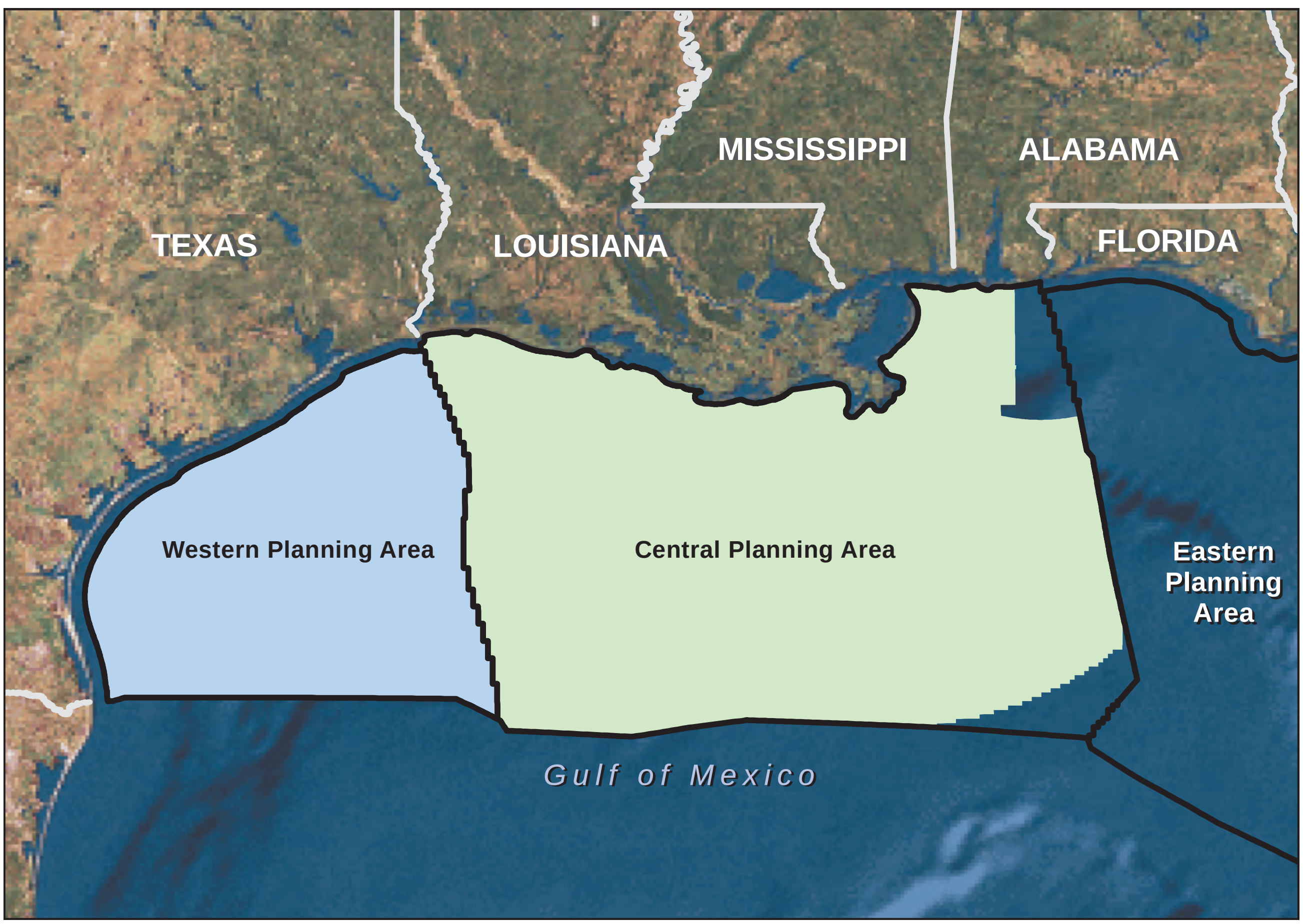
Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017

Western Planning Area Lease Sales 229, 233, 238, 246, and 248

Central Planning Area Lease Sales 227, 231, 235, 241, and 247

Final Environmental Impact Statement

Volume II: Chapters 4.2-4.5 and 5



U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

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CHAPTER 4

DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

4.2. PROPOSED CENTRAL PLANNING AREA LEASE SALES 227, 231, 235, 241, AND 247

The first proposed CPA lease sale is Lease Sale 227, scheduled to be held in 2013. The proposed CPA lease sale area encompasses about 63 million ac of the total CPA area of 66.45 million ac. This area begins 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama, and extends seaward to the limits of the United States' jurisdiction (often the Exclusive Economic Zone) in water depths up to approximately 3,346 m (10,978 ft) (**Figure 1-1**). As of May 2012, approximately 43.2 million ac of the CPA sale area are currently unleased. A CPA proposed action would offer for lease all unleased blocks in the CPA for oil and gas operations (**Figure 1-1**), with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006;

(2) blocks that are beyond the United States Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(3) whole and partial blocks that lie within the 1.4 nautical mile buffer zone north of the maritime boundary between the United States and Mexico.

Although the leasing of portions of the CPA and WPA (subareas or blocks) can be deferred during a Five-Year Program, DOI is conservative throughout the NEPA process and includes the total area within the Gulf of Mexico for environmental evaluation.

Chapter 4.2 presents baseline data for the physical, biological, and socioeconomic resources that would potentially be affected by a CPA proposed action or the alternatives, and it presents analyses of the potential impacts of routine events, accidental events, and cumulative activities on these resources. Baseline data are considered in the assessment of impacts from a proposed CPA lease sale on these resources. Programmatic aspects of climate change relative to the environmental baseline for the Gulf of Mexico OCS Program are discussed within each resource and in **Appendix G.3**.

The DWH event off the Louisiana coast resulted in the largest oil spill in U.S. history. Numerous values have been used in describing the oil spill caused by the DWH event. According to The Federal Interagency Solutions Group's (2010) Oil Budget Calculator, approximately 4.9 MMbbl of oil were released from the well. Of that volume, approximately 820,000 bbl were directly recovered via the riser insertion tube tool and the Top Hat. As a result, approximately 4.1 MMbbl were released into the environment over a period of 87 days. An event such as this has the potential to adversely affect multiple resources over a large area. The level of adverse effect depends on many factors, including the sensitivity of the resource as well as the sensitivity of the environment in which the resource is located. All effects may not initially be seen and some could take years to fully develop. The analyses of impacts from the DWH event on the physical, biological, and socioeconomic resources below are based on post-DWH credible scientific information that was publicly available at the time the document was prepared, applied using accepted methodologies. The conservative approach would be to expect that impacts from a lease sale may be greater than prior to the DWH event, although the magnitude of those impacts cannot yet be fully determined. The BOEM will continue to monitor these resources for effects caused by the DWH event.

Chapter 3.2.1 provides information on accidental spills that could result from all operations conducted under the OCS Program, as well as information on the number and sizes of spills from non-OCS sources. The number of spills ≥1,000 bbl and <1,000 bbl estimated to occur as a result of a CPA proposed action is provided in **Table 3-12**. The mean number of spills estimated for a CPA proposed action is <1-1 spill (≥1,000 bbl). The probabilities of a spill ≥1,000 bbl occurring and contacting modeled environmental resources are described in **Chapter 3.2.1.5.7** and **Figures 3-8 through 3-28**.

The potential impacts of a low-probability, large oil-spill event, such as the DWH event, to the environmental resources and socioeconomic conditions listed above are fully addressed in the "Catastrophic Spill Event Analysis" (**Appendix B**). The reader is referred to **Appendix B** for the analysis of a potential effect of a catastrophic event for each resource.

The following cumulative analyses consider impacts to physical, biological, and socioeconomic resources that may result from the incremental impact of a proposed CPA lease sale when added to all past, present, and reasonably foreseeable future human activities, including non-OCS activities, as well as all OCS activities (OCS Program). Environmental impacts of the cumulative case for the Gulf of Mexico resources are found in the individual resource analyses in **Chapters 4.1 and 4.2**, and a summary for the entire OCS Program is presented in **Appendix G.2**.

Non-OCS activities include, but are not limited to, import tankering; State oil and gas activity; recreational, commercial, and military vessel traffic; offshore LNG activity; recreational and commercial fishing; onshore development; and natural processes. The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the 40-year analysis period (2012-2051). This includes projected activity from lease sales that have been held, but for which exploration or development has not yet begun or is continuing.

Analytical Approach

The analyses of potential effects to the wide variety of physical, environmental, and socioeconomic resources in the vast area of the GOM and adjacent coastal areas is very complex. Specialized education, experience, and technical knowledge are required, as well as familiarity with the numerous impact-producing factors associated with oil and gas activities and other activities that can cause cumulative impacts in the area. Knowledge and practical working experience of major environmental laws and regulations such as NEPA, the Clean Water Act, CAA, CZMA, ESA, MMPA, the Magnuson-Stevens Fishery Conservation and Management Act, and others is also required.

In order to accomplish this task, BOEM has assembled a multidisciplinary staff with hundreds of years of experience. The vast majority of this staff has advanced degrees with a high level of knowledge related to the particular resources discussed in this chapter. This staff prepares the input to BOEM's lease sale EIS's, a variety of subsequent postlease NEPA reviews, and are also involved with ESA, EFH, and CZMA consultations. In addition, this same staff is also directly involved with the development of studies conducted by BOEM's Environmental Studies Program. The results of these studies feed directly into our NEPA analyses. To date, since 1973, approximately $350 million has been spent on physical, environmental, and socioeconomic studies in the Gulf of Mexico OCS Region. There are currently 89 ongoing studies in the Gulf of Mexico OCS Region, at a cost of about $48 million. A great deal of baseline knowledge about the GOM and the potential effects of oil and gas activities are the direct result of these studies. In addition to the studies staff, BOEM also has a Scientific Advisory Committee consisting of recognized experts in a wide variety of disciplines. The Scientific Advisory Committee has input to the development of the Environmental Studies Program on an ongoing basis.

For each lease sale EIS, a set of assumptions and a scenario are developed, and impact-producing factors that could occur from routine oil and gas activities, as well as accidental events, are described. This information is discussed in detail in **Chapter 3**. Using this information, the multidisciplinary staff described above applies their knowledge and experience to conduct their analyses of the potential effects of a CPA proposed lease sale.

The conclusions developed by the subject-matter experts regarding the potential effects of a proposed lease sale for most resources are necessarily qualitative in nature; however, they are based on the expert opinion and judgment of highly trained subject-matter experts. This staff approaches this effort in good faith utilizing credible scientific information available since the Macondo spill and applied using accepted methodologies. Where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives, and if so, was either acquired or in the event it was impossible or exorbitant to acquire the information, accepted scientific methodologies were applied in its place. This approach is described in the next subsection on "Incomplete or Unavailable Information."

Over the years, a suite of lease stipulations and mitigation measures has been developed to eliminate or ameliorate potential environmental effects, where implemented. In many instances, these were developed in coordination with other natural resource agencies such as NMFS and FWS. It must also be emphasized that, in arriving at the overall conclusions for certain environmental resources (e.g., coastal and marine birds, fisheries, and wetlands), the conclusions are not based on impacts to individuals, small groups of animals, or small areas of habitat, but on impacts to the resources/populations as a whole.

The BOEM has made conscientious efforts to comply with the spirit and intent of NEPA, to avoid being arbitrary and capricious in its analyses of potential environmental effects, and to use adaptive management to respond to new developments related to the OCS Program.

Incomplete or Unavailable Information

In the following analyses of physical, environmental, and socioeconomic resources, there are references to incomplete or unavailable information, particularly in relation to the DWH event and the associated oil spill. The subject-matter experts for each resource used what scientifically credible information was publicly available at the time this EIS was written, and acquired, when possible, new information. This new information is included in the description of the affected environment and impact analyses throughout **Chapter 4**. Where necessary, the subject-matter experts extrapolated from existing or new information, using accepted methodologies, to make reasoned estimates and developed conclusions regarding the current CPA baseline for resource categories and expected impacts from a proposed action given any baseline changes.

The most notable incomplete or unavailable information relates to the DWH event in the CPA. Credible scientific data regarding the potential short-term and long-term impacts from the DWH event on both CPA or WPA resources is becoming available but remains incomplete at this time, and it could be many years before this information becomes available via the Natural Resource Damage Assessment (NRDA) process, BOEM's Environmental Studies Program, and numerous studies by academia. Nonetheless, the subject-matter experts acquired and used newly available, scientifically credible information, determined that other additional information was not available absent exorbitant expenditures or could not be obtained regardless of cost in a timely manner, and where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information.

It is important to note that, barring another catastrophic oil spill, which is a low-probability accidental event, the adverse impacts associated with a CPA proposed lease sale are small, even in light of the DWH event. This is because of BOEM's lease sale stipulations and mitigations, site-specific mitigations that become conditions of plan or permit approval at the postlease stage, and mitigations required by other State and Federal agencies. Lease sale stipulations may include the Topographic Features Stipulation; the Live Bottom Stipulation; the Military Areas Stipulation; the Evacuation Stipulation; the Coordination Stipulation; the Blocks South of Baldwin County, Alabama, Stipulation; the Protected Species Stipulation; the Law of the Sea Convention Royalty Payment Stipulation; the Below Seabed Operations Stipulation; and the Transboundary Stipulation. Site-specific postlease mitigations may include buffer zones and avoidance criteria to protect sensitive resources such as areas of live bottoms, topographic features, chemosynthetic communities, deepwater corals, and historic shipwrecks. Mitigations may also be required by other agencies (i.e., the U.S. Army Corps of Engineers and State CZM agencies) to reduce or avoid impacts from OCS activities include boring under beach shorelines and the rerouting of pipelines to reduce or eliminate impacts from OCS pipelines that make landfall.

For the following resources, the subject-matter experts determined that there is incomplete or unavailable information that is relevant to reasonably foreseeable significant adverse impacts; however, it is not essential to a reasoned choice among alternatives.

- Air Quality (**Chapter 4.2.1.1**)
- Water Quality (Coastal and Offshore) (**Chapters 4.2.1.2.1 and 4.2.1.2.2**, respectively)
- Coastal Barrier Beaches and Associated Dunes (**Chapter 4.2.1.3**)
- Wetlands (**Chapter 4.2.1.4**)
- *Sargassum* Communities (**Chapter 4.2.1.8**)
- Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities (**Chapters 4.2.1.9 and 4.2.1.10**, respectively)
- Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice (**Chapter 4.2.1.15**)
- Commercial Fisheries (**Chapter 4.2.1.19)**
- Recreational Resources (**Chapter 4.2.1.20**)

- Archaeological Resources (Historic and Prehistoric) (**Chapters 4.2.1.22.1 and 4.2.1.22.2**, respectively)
- Land Use and Coastal Infrastructure (**Chapter 4.2.1.23.1**)
- Economic Factors (**Chapter 4.2.1.23.3**)
- Soft-Bottom Benthic Communities (**Chapter 4.2.1.11**)

For the following resources, the subject-matter experts determined that there is incomplete or unavailable information that is relevant to reasonably foreseeable significant adverse impacts and may be essential to a reasoned choice among alternatives. The subject-matter experts determined that, in many instances, the cost of obtaining the information was exorbitant or that, regardless of cost, it could not be obtained within the timeframe contemplated by this NEPA analysis. In place of the incomplete or unavailable information, the subject-matter experts used what scientifically credible information was available applied using accepted scientific methodologies.

- Seagrass Communities (**Chapter 4.2.1.5**)
- Live Bottoms (Pinnacle Trend and Low Relief) (**Chapters 4.2.1.6.1 and 4.2.1.6.2**, respectively)
- Topographic Features (**Chapter 4.2.1.7**)
- Marine Mammals (**Chapter 4.2.1.12**)
- Sea Turtles (**Chapter 4.2.1.13**)
- Coastal and Marine Birds (**Chapter 4.2.1.16)**
- Gulf Sturgeon (**Chapter 4.2.1.17**)
- Fish Resources and Essential Fish Habitat (**Chapter 4.2.1.18**)
- Environmental Justice (**Chapter 4.2.1.23.4**)
- Diamondback Terrapins (**Chapter 4.2.1.24**)

This chapter has thoroughly examined the existing credible scientific evidence that is relevant to evaluating the reasonably foreseeable significant adverse impacts of a CPA proposed lease sale on the human environment. The subject-matter experts that prepared this EIS conducted a diligent search for pertinent information, and BOEM's evaluation of such impacts is based upon theoretical approaches or research methods generally accepted in the scientific community. All reasonably foreseeable impacts were considered, including impacts that could have catastrophic consequences, even if their probability of occurrence is low. Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it is essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether generally accepted scientific methodologies can be applied in its place (40 CFR 1502.22).

4.2.1. Alternative A—The Proposed Action

4.2.1.1. Air Quality

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and the proposed action's incremental contribution to the cumulative impacts are presented in this section. A brief summary of potential impacts follows. Emissions of pollutants into the atmosphere from the routine activities associated with a CPA proposed action are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline; and the impacts of the OCS emissions on the onshore air quality are expected to be well within the National Ambient Air Quality Standards (NAAQS). While regulations are in place to reduce the risk of impacts from H_2S and while no H_2S-related deaths have occurred on the OCS, accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. These emissions from routine activities and accidental events associated with a CPA proposed action are not expected to have concentrations that would change onshore air quality classifications. The total impact from all onshore and offshore emissions (such as roads, power generation, and industrial activities) would continue to significantly affect the ozone nonattainment areas in southeast Texas and the parishes near Baton Rouge, Louisiana. A CPA proposed action would have an insignificant contribution to ozone levels in the nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS.

4.2.1.1.1. Description of the Affected Environment

The Clean Air Act (CAA) established the NAAQS. The primary standards are to protect public health, and the secondary standards are set to protect public welfare, such as visibility or to protect vegetation, as shown in **Table 4-1.** The current NAAQS address six pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), particulate matter (PM), ozone (O_3), and sulfur dioxide (SO_2) (**Table 4-1)**. Particulate material is presented as two categories according to size. Coarse particulate matter is between 2.5 μm and 10 μm (PM_{10}), and fine particulate matter is less than 2.5 μm in size ($PM_{2.5}$). Under the CAA, USEPA is periodically required to review and, as appropriate, modify the criteria based on the latest scientific knowledge. Several revisions to the NAAQS have occurred in the past several years, as more is understood about the effects of the pollutants.

Operations west of 87.5^o W. longitude fall under BOEM jurisdiction for enforcement of the Clean Air Act. The OCS waters east of 87.5^o W. longitude are under the jurisdiction of USEPA. **Figure 4-1** presents the air quality status in the Gulf Coast States as of 2010. The nonattainment areas for ozone are shown in **Figure 4-1**. In May 2008, the new 8-hour ozone standard NAAQS of 0.075 ppm was promulgated.

Effective December 17, 2006, USEPA revoked the annual PM_{10} standard and revised the 24-hour $PM_{2.5}$ from 65 μg/m^3 to 35 μg/m^3. In early 2008, USEPA promulgated a new, more restrictive NAAQS 8-hour O_3 standard of 0.075 ppm.

Although final summary information and reports on air quality impacts from the DWH event may be forthcoming, USEPA, NOAA, and other agencies obtained and released to the public a large number of air quality measurements indicating that air impacts tended to be minor and below USEPA's health-based standards. As there are no continuing sources of air pollution related to the DWH event, BOEM would not expect any additional measurements or information to alter the conclusions from currently existing data. As such, although there is incomplete or unavailable information on air quality impacts at this time that may be relevant to reasonably foreseeable adverse impacts, this information is not essential to a reasoned choice among alternatives.

Attainment Status

Air quality depends on multiple variables—the location and quantity of emissions; dispersion rates, distances from receptors, and local meteorology. Meteorological conditions and topography may confine, disperse, or distribute air pollutants in a variety of ways.

The Clean Air Act Amendments of 1990 (CAAA) established classification designations based on the monitoring of ambient air quality. These designations determine dates by which the standard must be attained through the implementation of emission control requirements. When measured concentrations of regulated pollutants exceed the NAAQS, the area is designated nonattainment. The severity of the nonattainment problem is determined by calculating the 3-year average of the highest measured ozone concentration in each year. The CAAA established five classifications for ozone nonattainment areas—marginal, moderate, serious, severe, and extreme.

There is no provision in the CAA for classification for the OCS. Only areas within State boundaries are classified as either attainment, nonattainment, or unclassifiable.

Louisiana is in attainment for the pollutants CO, SO_2, NO_2, and $PM_{10,}$. The O_3 nonattainment parishes in Louisiana are in the Baton Rouge area and include Ascension, East Baton Rouge, Iberville, Livingston, and West Baton Rouge Parishes (USEPA, 2011b). More recent monitoring data collected in the period 2006-2009 indicated that the Baton Rouge nonattainment area has not had any violations of the 8-hour ozone standard. The State is in the process of submitting the needed information so that USEPA can redesignate the area to attainment (*Federal Register*, 2010c). A steady decline in ozone concentration over the last two decades is a result of emission control measures to reduce ozone precursor emissions (Louisiana Dept. of Environmental Quality, 2004). The average number of ozone exceedances in the area has declined, as has the number of air-pollution monitors recording exceedances.

Alabama and Mississippi are in attainment for CO, SO_2, NO_2, PM, and O_3 (USEPA, 2011b).

The PSD Class I air quality areas, designated under the Clean Air Act, are afforded the greatest degree of air quality protection and are protected by stringent air quality standards that allow for very little deterioration of their air quality. On January 22, 2010, USEPA established a new 1-hour NAAQS for NO_2 at 100 ppb (approximately 189 $\mu g/m^3$). The increments are the 2.5 $\mu g/m^3$ 3-hour increment for NO_2, a 5 $\mu g/m^3$ 24-hour increment and 2 $\mu g/m^3$ annual increment for SO_2, and an 8 $\mu g/m^3$ 24-hour increment and 4 $\mu g/m^3$ annual increment for PM_{10}. The PSD increments have been established for $PM_{2.5}$. For a PSD Class I area, these are 1 $\mu g/m^3$ for the annual average and 2 $\mu g/m^3$ for the 24-hour average. The CPA includes the Breton National Wildlife Refuge and National Wilderness Area (BNWA) south of Mississippi, which is designated as a PSD Class I area. The FWS has responsibility for protecting wildlife, vegetation, visibility, and other sensitive resources called air-quality-related values in this area. The FWS has expressed concern that the NO_2 and SO_2 increments for the BNWA have been consumed. In addressing the FWS concern, this Agency has conducted a scientific study to determine the pollutant increment status at BNWA. The results obtained from this study show that the maximum 3-hour, 24-hour, and annual SO_2 increments were not exceeded within the BNWA, but a portion of the increment was consumed (Wheeler et al., 2008). Likewise, the maximum annual NO_2 increment was not exceeded within the BNWA, but a portion of the increment was consumed.

The exact effect of the DWH event on the BNWA is not known because of the unavailability of air quality data specific to the area. However, it is expected that the effect of the DWH event on the air quality at the BNWA would be small since the air emissions from the DWH event were temporary sources and all air quality data for other areas of the Gulf Coast remained below USEPA's health-based standards.

Jurisdiction

The responsibilities of BOEM are described in the OCSLA (43 U.S.C. 1334(a)(8)), which requires the Secretary of the Interior to promulgate and administer regulations that comply with the NAAQS, pursuant to the CAA (42 U.S.C. 7401 *et seq*.) and to the extent that activities authorized significantly affect the air quality of any State. Section 328 of the 1990 Clean Air Act Amendments transferred jurisdiction over emission sources on the OCS from DOI to USEPA for OCS waters east of 87.5° W. longitude. Air emission sources west of 87.5° W longitude in the GOM remain under BOEM jurisdiction.

The USEPA promulgated OCS air quality regulations to implement the statutory requirements (40 CFR 55). Over the past several years, BOEM has leased some blocks that are east of 87.5° W. longitude. These lessees are working with USEPA to obtain permits for exploratory drilling activities (USEPA, 2011f).

Emission Inventories

The BOEM conducts the Gulfwide Emission Inventory Study (Gulfwide Offshore Activities Data System [GOADS]) every 3 years. The purpose of the GOADS study is to assess the potential impacts of air-pollutant emissions from offshore oil and gas exploration and production. The BOEM supplies the operators with GOADS Visual Basic activity data collection software for compiling monthly activity data for the calendar year. Each study estimates emissions for all OCS oil and gas production-related sources in the Gulf of Mexico. Data are collected from 16 different sources on the platform, such as amine units, diesel engines, and flashing losses. The inventory includes non-platform sources (such as pipelaying operations) and non-OCS oil/gas-related emissions (such as commercial fishing vessels), and it estimates a geogenic and biogenic contribution. The collected activity data are submitted to BOEM in April of the year following the collection effort. A rigorous quality control process is performed on the submitted data by BOEM's contractor. The activity data are combined with the most recent emission factors published by USEPA and the Emission Inventory Improvement Program's emission estimation methods to develop a comprehensive criteria pollutant and greenhouse gas emissions inventory. Data files that are suitable for use in air quality modeling applications are generated. For each piece of equipment, stack parameter information such as outlet height, exit velocity, and exhaust gas temperature is presented.

The CAAA requires BOEM to coordinate air-pollution control activities with USEPA. Thus, there will be a continuing need for emission inventories and modeling in the future. The following is a summary of new information that has become available in the past several years.

The BOEM has completed three air emissions inventory studies for calendar years 2000 (Wilson et al., 2004), 2005 (Wilson et al., 2007), and 2008 (Wilson et al., 2010). These studies estimated emissions for all OCS oil and gas production-related sources in the Gulf of Mexico, including nonplatform sources, as well as other non-OCS-related emissions. The inventories included carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), PM_{10}, $PM_{2.5}$, and VOC's, as well as greenhouse gases—carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Another emission inventory is underway for 2011. These emissions inventories will be used in air quality modeling to determine the potential impacts of offshore sources to onshore areas.

Greenhouse Gas Reporting

In response to the FY 2008 Consolidated Appropriations Act, USEPA issued 40 CFR 98, which requires reporting of greenhouse gas emissions. Subpart W of the Greenhouse Gases Reporting Rule requires petroleum and natural gas facilities that emit 25,000 metric tons or more of CO_2 equivalents per year to report emissions from equipment leaks and venting. Subpart C of the Greenhouse Gases Reporting Rule requires operators to report greenhouse gas emissions from general stationary fuel combustion. For Subpart W of the reporting rule, USEPA accepts industry data collected via BOEM's GOADS project to estimate the emissions of CH_4 and CO_2 from stationary fugitive and stationary vented sources.

General Conformity Regulations

New General Conformity regulations were promulgated on March 24, 2010 (USEPA, 2011c). This regulation applies only to emissions within a nonattainment area. It does not apply to OCS emissions, except for any OCS-related emissions that may occur within State waters, such as vessels. The BOEM has not had to do any conformity determinations for OCS oil- and gas-related activities in the Gulf of Mexico.

The accidental impacts from a catastrophic spill, such as the DWH event, are analyzed in **Chapter 4.2.1.1.3 and Appendix B**. The DWH event caused effects on air quality; these effects occurred from the application of dispersants to the oil spill, in-situ oil burning, evaporation of toxic chemicals from the oil spill, and cleanup activities. Onshore air quality data indicate that USEPA's health-based standards were not exceeded, although there were public complaints regarding health concerns (**Chapter 4.2.1.23.4**).

An oil spill could cause the release and transport of particulate matter to the onshore environment and increase the ozone concentration or the amount of toxic chemicals in the onshore environment. The onshore residents and cleanup workers may be exposed to toxic chemicals, particulate matter, or ozone, and they may experience short-term or long-term health effects.

In response to the recent DWH event, USEPA and the affected States conducted extensive air quality monitoring along the Gulf Coast. The air monitoring conducted to date has found that the levels of ozone and particulates were at levels well below those that would cause short-term health problems (USEPA, 2010j). The air monitoring also did not find any pollutants at levels expected to cause long-term harm. However, it has been reported in the news that people along the coastal areas felt the effect of the toxic chemicals released from the DWH event and the sprayed dispersant (**Chapter 4.2.1.21.4**).

Modeling tools for the transport and dispersion of air pollutants such as ozone, carbon monoxide, nitrogen dioxide, and PAH's are required to determine the fate and pollutant concentrations in the environment and, subsequently, to assess environmental impacts. The BOEM regulations require that when modeling is needed it follow USEPA guidelines published in Appendix W of 40 CFR 51. The OCD Model has been the preferred model. Efforts are underway to improve representation of overwater conditions and to increase the selection of models that may be used. In a catastrophic spill, dispersants may be sprayed to break up the slick. The dispersant mist would temporarily degrade the air quality.

In a catastrophic spill, oil may be burned to prevent it from entering sensitive habitats. The USEPA released two peer-reviewed reports concerning dioxins emitted during the controlled burns of oil during the DWH event (Aurell and Gullet, 2010; Schaum et al., 2010). Dioxins is a category that describes a group of hundreds of potentially cancer-causing chemicals that can be formed during combustion or burning. The reports found that, while small amounts of dioxins were created by the burns, the levels that workers and residents would have been exposed to were below USEPA's levels of concern. The increased risk of cancer in exposed populations was less than 1 additional cancer in 1 million people.

However, at present, a number of scientists, doctors, and health care experts are concerned with the potential public health effects as a result of the DWH event in the Gulf of Mexico. The effects of the DWH event on public health and the environment can be classified as short-term and long-term effects. The short-term effects include watery and irritated eyes, skin itching and redness, coughing, and shortness of breath or wheezing. As yet, little is known about any long-term health effects of direct exposure to oil from the DWH event. Past accidental oil-spill events do not provide guidance for the assessment of the long-term impact of the DWH event on public health (**Chapter 4.2.1.21.4**).

4.2.1.1.2. Impacts of Routine Events

Background/Introduction

The following routine activities associated with a CPA proposed action would potentially affect air quality: platform construction and emplacement; platform operations; drilling activities; flaring; seismic-survey and support-vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers; and fugitive emissions. Supporting materials and discussions are presented in **Chapter 4.2.1.1.1**. The impact analysis is based on four parameters—emission rates, surface winds, atmospheric stability, and the mixing height.

The BOEM conducts a review of the impacts of each EP and DOCD to onshore air quality during the postlease plans review process (**Chapter 1.5**). Operators submit their projected maximum emissions in order to obtain plan approval. The projected emissions are compared with exemption thresholds. If the emissions exceed the exemption thresholds, OCD modeling is performed. The operator can chose to customize their submittal by using actual fuel use rather than the BOEM-provided default factors or submitting manufacturer's emissions specifications. They may also reduce emissions by spacing out the activity over time or selecting a different rig.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. Natural gas from the Norphlet Formation in the northeastern portion of the CPA, just south of Alabama and Mississippi, tends to range between 40 and 140 ppm on the OCS. Nevertheless, two wells are known to have H_2S concentrations of 1.8 and 2.5 percent (18,000 and 25,000 ppm, respectively) in the OCS. Higher concentrations do occur within the Norphlet Formation farther north under State territorial waters and below land.

Additionally, the area around the Mississippi River Delta is a known sulfur-producing area. The natural gas in deepwater reservoirs has been mainly sweet (i.e., low in sulfur content), but the oil averages between 1 and 4 percent sulfur content by weight. By far, most of the documented production of sour gas (i.e., high sulfur content) lies within 150 km (93 mi) of the Breton National Wilderness Area.

Flaring of gas containing H_2S (sour gas) is of concern because it could significantly impact nearby onshore areas, particularly when considering the short-duration averaging periods (1 and 24 hour) for SO_2. The contribution of flaring to SO_2 is regulated in 30 CFR 250 Subpart K. For areas and activities under BOEM jurisdiction, BOEM's regulations may be different from those of USEPA.

SO_x levels from routine flaring are evaluated as part of the postlease plans review process. Emergency requests to vent or flare gas or burn oil are made when a well test occurs, when equipment is going to be upgrading, or when a pipeline is going to repaired and there is no other pipeline to divert the gas or oil. When emergency flaring is required, the operator requests permission from BSEE. The BSEE refers the request to BOEM. The amount of SO_2 generated is dependent upon the sulfur concentration, rate of flaring, and the presence and functioning of a sulfur recovery unit. The BOEM compares the estimated SO_x to a threshold exemption level based on the distance to shore. If the projected maximum pounds per hour SO_x emission level will exceed the threshold, BOEM informs the operator of the rate that they must not exceed. The operator may install an amine unit temporarily in order to flare at a higher rate. Routine and emergency flaring that is a normal part of a proposed action is not expected to result in SO_x levels that impact onshore levels.

The BSEE and BOEM recently issued a final rule (30 CFR 250.490 and 30 CFR 550.215, respectively [*Federal Register*, 2011a]) governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulfur dioxide, protecting personnel, providing warning systems and signage, and establishing requirements for hydrogen sulfide flaring and venting.]

The combustion of liquid hydrocarbon fuel is the primary source of sulfur oxides (SO_x) when considering the annual averaging period; however, impacts from high-rate well cleanup operations can generate significant SO_2 emissions. To prevent inadvertently exceeding established criteria for SO_2 for the 1-hour and 24-hour averaging periods, all incinerating events involving H_2S or liquid hydrocarbons containing sulfur are reported to BSEE and are evaluated individually for compliance with safety and flaring requirements. The lessees must not flare or vent oil well gas for more than 48 continuous hours unless BSEE's Regional Supervisor approves (30 CFR 250.1160). The VOC's are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's is the vents on glycol dehydrator units.

Emissions of air pollutants would occur during exploration, development, and production activities. The profile of typical emissions for exploratory and development drilling activities shows that emissions of NO_x are the most prevalent pollutant of concern. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole and lower stack heights. During exploratory drilling operations, air emissions may be high enough to contribute to exceedances of the new short-term, 1-hour NO_x and SO_x NAAQS and, hence, may affect the onshore air quality.

Platform emission rates for the GOM region are provided from the 2008 emission inventory of OCS sources (Wilson et al., 2010). This compilation was based on information from a survey of 3,304 platforms from 103 companies, which represented an 85 percent response rate. Since these responses included all the major oil and gas production facilities, they were deemed representative of the type of emissions to be associated with a platform. The NO_x and VOC's are the primary pollutants of concern since both are considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were taken from the OCS emission inventory (Wilson et al., 2010). The number of wells expected to be developed per year in the WPA and CPA are listed in **Tables 3-2 and Table 3-3**, respectively.

Flaring is the venting and/burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/of production equipment. The BSEE operating regulations provide for some limited volume, short duration flaring or venting of some natural gas volumes upon approval by BSEE. These operations may occur for short periods of time (typically 2-14 days) as part of unloading/operations that are necessary to remove potentially damaging completion fluids from the wellbore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Accidents, such as oil spills, blowouts, and pipeline ruptures, are another source of emissions related to OCS operations. The potential impacts from these accidental events are discussed in **Chapter 4.2.1.1.3**.

Atmospheric pollutants are transported by prevailing winds and are diluted through dispersion. During summer, the wind regime in the CPA is predominantly onshore at mean speeds of 3-5 m/sec (6.7-11.2 mph). Average winter winds are predominantly offshore at speeds of 4-8 m/sec (8.9-17.9 mph) (**Appendix A.3**). Although for the summer months the wind regime in the CPA is predominantly onshore during the day, OCS activities would not be expected to impact air pollutant levels in the CPA because any pollutants emitted would be dispersed prior to reaching shore. The majority of OCS Program-related emissions occur offshore anywhere from the State/Federal waters boundary to 200 mi (322 km) offshore, which limits the potential for emissions to result in impacts onshore.

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions within the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a good indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the CPA (Florida A&M University, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height determines the vertical space available for spreading the pollutants. The mixing height is the height above the surface of the earth through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions and is suppressed during stable conditions resulting in the worst periods of air quality. Although mixing height information throughout the GOM is scarce, measurements near Panama City, Florida (Hsu, 1979), show that the mixing height can vary between 400 and 1,300 m (1,312 and 4,265 ft), with a mean of 900 m (2,953 ft). The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

The annual CO_2 emissions in the WPA and CPA are estimated at 0.34 and 1.3 million tons, respectively. The CO_2 emissions attributable to the WPA and CPA are estimated to be about 0.005 percent of total global CO_2 emissions annually. The United States' CO_2 emissions in 2008 were estimated to be 7.1 billion metric tons CO_2 equivalents. In 2010, total U.S. greenhouse gas emissions were 6.8 billion metric tons CO_2 equivalents. Total U.S. emissions have increased by 10.5 percent from 1990 to 2010, and emissions increased from 2009 to 2010 by 3.2 percent (213.5 teragrams CO_2 equivalents). The CO_2 equivalent emissions from total offshore sources (including non-OCS sources) are 0.45 percent of the total United States' GHG Inventory using 2008 numbers. The CO_2 equivalent emissions from specifically OCS oil and gas sources is 0.4 percent of the United States' GHG Inventory.

The amount of CO_2 emissions from a typical well site on average is about 237-439 tons per year. This is well below the reporting thresholds under the GHG Reporting Rule. Given these emissions estimates, greenhouse gas emissions attributable to the CPA and WPA would not be expected to contribute significantly to the global warming or climate change.

Proposed Action Analysis

The OCS emissions in tons per year for the criteria pollutants for a CPA proposed action are indicated in **Table 4-64**. The annual OCS emissions in **Table 4-2** are based on the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) and the scenario. The scenario is provided in **Chapter 3** and details the number of wells drilled, production structures installed and removed, and the method of product transportation for a single typical lease sale. The major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a CPA proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. The drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 40-day drilling period. Support activities for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and the offshore facilities; a smaller percentage of the emissions occur during idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

The total pollutant emissions per year are not uniform. At the beginning of the proposed activities, emissions would be the largest. Emissions peak early on, as development and drilling start relatively quickly, followed by production. After reaching a maximum, emissions would decrease as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

The BOEM regulations (30 CFR 550.303) establish 1-hour and 8-hour significance levels for CO. A comparison of the projected emission rate to BOEM's exemption level would be used to assess CO impacts. The formula to compute the emission rate in tons/year for CO is $3,400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. It has been found that the air emissions of CO do not exceed BOEM's exemption level. This pollutant is not an ambient air pollutant of concern in the offshore oil and gas industry. Therefore, CO modeling analysis is not performed.

The VOC emissions (as a precursor pollutant) are best addressed as their corresponding ozone impacts, which were studied in the *Gulf of Mexico Air Quality Study* (GMAQS) (Systems Applications International et al., 1995). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas, including the Houston/Beaumont, Port Arthur/Lake Charles, and Baton Rouge areas. In the model, total OCS contributions to the O_3 levels at locations where the model predicted O_3 concentrations above the NAAQS in O_3 episodes modeled were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities, and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under a CPA proposed action would not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this conservative scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). The new 8-hour ozone standard (0.075 ppm) was promulgated on May 27, 2008. It is more stringent than the previous 1-hour standard as well as the old 8-hour standard. In response to the 1997 ozone standard (0.08 ppm), the updated ozone modeling was performed using a preliminary Gulfwide emissions inventory for the year 2000 to examine the O_3 impacts with respect to the new 8-hour ozone standard. Two modeling studies were conducted. One modeling study focused on the coastal areas of Louisiana extending eastward to Florida (Haney et al., 2004). This study showed that the impacts of OCS emissions on onshore O_3 levels were very small, with the maximum contribution of 1 ppb or less at locations where the standard was exceeded. The other modeling effort dealt with O_3 levels in southeast Texas (Yarwood et al., 2004). The results of this study indicated a maximum contribution of 0.2 ppb or less to areas exceeding the standard ozone increment.

Annual modeling with the CALPUFF model of the study (2000-2001) and baseline years (1977 for SO_2 and 1988 for NO_2) revealed that none of the allowable SO_2 or NO_2 increments had been fully consumed, as shown in the table below (Wheeler et al., 2008).

Comparison of the Allowable SO_2 or NO_2 Increment
in the BNWA with the NAAQS

Increment	Class I Area (BNWA) (ug/m^3)	Allowable Increment (ug/m^3)
3-hr SO_2	1.7	25
24-hr SO_2	1.18	5
Maximum Annual SO_2	1.07	2
Maximum Annual NO_2	0.1	2.5

The OCD modeling results for the CPA are presented in Tables 4-26 and 4-27 of the 2007-2012 Multisale EIS (USDOI, MMS, 2007c); these tables are hereby incorporated by reference. The BOEM has presumed that these tables are adequate because of the similarities between the 2007-2012 Multisale EIS (USDOI, MMS, 2007c) and the 2012-2017 Multisale EIS scenarios. The increase in the number of exploration and delineation wells occurs at all water depths; therefore, increased emissions would be throughout the CPA rather than concentrated in blocks nearer to shore. These tables do not include the 1-hour NO_x and SO_x modeling results. The BOEM has relied on 1-hour NO_x OCD modeling performed by operators during the postlease plans approval to validate that projected emissions do not exceed the 1-hour NO_x standard. SO_x exceedances of the hourly and annual exemption levels are less frequent. Therefore, BOEM has not required SO_x modeling since the 1-hour SO_x standard went into effect.

Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible. It is estimated that over 99 percent of the gas and oil would be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer would be small, as would the associated exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Louisiana (Marine Vapor Recovery Act, 2010, LAC 33:III.2108 [Louisiana Dept. of Environmental Quality, 2010b]).

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter (diameter of a sphere) that would have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 µm and a third peak with a diameter larger than 2 µm. Particles with diameters of 2 µm or larger settle very close to the source (residence time of approximately ½ day, Lyons and Scott, 1990). For particles smaller than 2 µm, which do not settle fast, wind transport determines their impacts. Projected PM_{10} concentrations are expected to have a low impact on the visibility of PSD Class I areas.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with the size in the range of 1 to 2 microns (micrometers). The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC's may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute to the visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area. Although boundary changes have opened up more area for exploration and production on the eastern side of the CPA, the area closest to shore and the Class I area cannot be leased as a result of GOMESA. Since future air emission from all sources in the area are expected to be about the same level or less, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

The Breton National Wilderness Area is a Class I air quality area administered by FWS. Under the Clean Air Act, BOEM would notify FWS and the National Park Service if emissions from proposed projects may impact the Breton Class I area. Mitigating measures and stricter air emissions monitoring and reporting requirements are required for sources that are located within 100 km (62 mi) of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the routine activities associated with a CPA proposed action are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. The ambient concentrations of pollutants due to emissions from proposed-action activities in the CPA are expected to be well within the NAAQS. As indicated in the GMAQS and other modeling studies, a CPA proposed action would have only a small effect on ozone levels in ozone nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS. The OCD modeling results incorporated by reference from the 2007-2012 Multisale show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas. One-hour NO_x modeling performed by operators as part of the postlease approval process indicates concentrations less than the maximum increase allowed. Regulations, activity data reporting via the GOADS reporting requirement, and mitigation such as monitoring the performance of the sulfur recovery unit or the catalytic converter would ensure these levels stay within the NAAQS.

4.2.1.1.3. Impacts of Accidental Events

Background/Introduction

The accidental release of hydrocarbons related to a CPA proposed action would result in the emission of air pollutants. The OCS accidents could include the release of oil, condensate, or natural gas or chemicals used offshore or pollutants from the burning of these products. The air pollutants include criteria NAAQS pollutants, volatile and semi-volatile organic compounds, H_2S, and methane. These pollutants are discussed in **Chapter 4.2.1.1.2**. If a fire was associated with the accidental event, it would produce a broad array of pollutants, including all NAAQS-regulated primary pollutants, including NO_2, CO, SO_x, VOC, PM_{10}, and $PM_{2.5}$. The discussion below addresses a 2,200-bbl spill. In the spill size category of ≥1,000 bbl, the estimated median spill size based on historical data is 2,200 bbl (**Table 3-12**).

A catastrophic event is a high-volume, long-duration oil spill. An analysis of the impact of a catastrophic spill is included in **Appendix B**. Many Federal and State agencies and companies participate in the response to a catastrophic event such as the DWH event. Air quality onshore and on-water was monitored by OSHA, USCG, and the responsible party to ensure a safe work environment for response workers. Coastal community air quality was monitored by USEPA and State environmental agencies. The results from these efforts are available on DWH event websites (USEPA, 2010j).

Proposed Action Analysis

The accidental release of hydrocarbons or chemicals from a CPA proposed action would cause the emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere. Accidents, such as oil spills and blowouts, are a source of emissions related to OCS operations. Typical emissions from OCS accidents consist of hydrocarbons; only fires produce a broad array of pollutants, including all NAAQS-regulated primary pollutants. The criteria pollutants considered here are NO_2, CO, SO_2, VOC, PM_{10}, and $PM_{2.5}$.

NAAQS Pollutants

Some of the NAAQS pollutants, the VOC's and NO_x, are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere. Human exposure to ground-level ozone exposure causes a variety of health problems including airway irritation, aggravation of asthma, and increased susceptibility to respiratory illnesses. Ozone levels could increase, especially if the oil spill were to occur on a hot, sunny day with sufficient concentrations of NO_x present in the lower atmosphere. An accidental spill would possibly have a temporary, offshore localized adverse effect due to NAAQS pollutant concentrations. Due to the distance from shore and an assumed accidental spill size of 2,200 bbl, an oil spill would not affect onshore ozone concentrations.

The VOC emissions from the evaporation of an oil spill can contribute to the formation of particulate matter ($PM_{2.5}$). In-situ burning also generates particulate matter. Particulate matter can cause adverse human respiratory effects and can also result in a haze. The $PM_{2.5}$ concentrations in a plume could have the potential to temporarily degrade visibility in any affected PSD Class I areas (i.e., National Wilderness Areas and National Parks) such as the Breton National Wilderness Area in the CPA and other areas where visibility is important.

Hydrocarbons

Oil is a mixture of many different chemical compounds, some of which are hazardous to health. Toxic chemicals can cause headaches or eye irritation and some other symptoms. Benzene can cause cancer at high levels and long exposures. The benzene, toluene, ethylbenzene, and xylene (BTEX) fraction of oil is light and volatilizes into air. The BTEX level is commonly measured to provide an indication of the level air quality. During an accidental spill, the levels of BTEX in the immediate area could exceed safe levels. In hazardous conditions, OSHA and USCG regulations require workers to use breathing protection. An accidental spill would possibly result in temporary, offshore localized elevated levels of hydrocarbons. Due to the distance to shore and an assumed accidental spill size of 2,200 bbl, an accidental spill would not result in elevated onshore BTEX concentrations. An analysis of the impact of a catastrophic spill, of far greater size, is included in **Appendix B**.

Hydrogen Sulfide (H_2S)

The presence of H_2S within formation fluids occurs sporadically throughout the Gulf of Mexico OCS and may be released during an accident. The concentrations of H_2S found to date are generally greatest in the eastern portion of the CPA. There has been some evidence that petroleum from deepwater areas contains significant amounts of sulfur. The H_2S concentrations in the OCS vary from as low as a fraction of a ppm to as high as 650,000 ppm. H_2S can cause acute symptoms, including headaches, nausea, and breathing problems. During an accidental event, H_2S concentrations could be high enough in the immediate area to be life threatening. The BSEE's regulations (30 CFR 250.490(a)(1)) and the clarifying H_2S NTL (NTL 2009-G31) requires a Contingency Plan, as well as sensors and alarms (30 CFR 250.490(d)) to alert and protect workers from H_2S releases.

In-situ Burning

In-situ burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10}, and would generate a plume of black smoke. Fingas et al. (1995) describes the results of a monitoring program of a burn experiment at sea. The program involved extensive ambient measurements during two experiments in which approximately 300 bbl of crude oil were burned. It found that during the burn, CO, SO_2, and NO_2 were measured only at background levels and were frequently below detection levels. Ambient levels of VOC's were high within about 100 m (328 ft) of the fire but were significantly lower than those associated with a nonburning spill. Measured concentrations of polycyclic aromatic hydrocarbons (PAH's) were low. It appeared that a major portion of these compounds was consumed in the burn. In measurements taken from the NOAA WP-3D aircraft during the DWH event, lofted plumes from the controlled burns rose above the marine boundary layer of 2,000 ft (610 m) (Ravishankara and Goldman, 2010).

McGrattan et al. (1995) modeled smoke plumes associated with in-situ burning. The PM is the type of particulates matter measured. The results showed that the surface concentrations of particulate matter did not exceed the health criterion of 150 $\mu g/m^3$ in 24 hours beyond about 5 km (3 mi) downwind of an in-situ burn. This is quite conservative since this health standard is based on a 24-hour average concentration rather than a 1-hour average concentration. This appears to be supported by field experiments conducted off of Newfoundland and in Alaska. In summary, the impacts from in-situ burning are temporary. Pollutant concentrations would be expected to be within the NAAQS. The air quality impacts from in-situ burning would therefore be minor.

Dioxins and furans are a family of extremely persistent chlorinated compounds that magnify in the food chain. During an in-situ burn, the conditions exist (i.e., incomplete hydrocarbon combustion and the presence of chlorides in seawater) for dioxins and furans to potentially form. Measurements of dioxins and furans during the DWH event in-situ burning were made (Aurell and Gullett, 2010). The estimated levels of dioxins and furans produced by the in-situ burns were similar to those from residential woodstove fires and slightly lower than those from forest fires, according to USEPA researchers (Schaum et al., 2010) and roughly 25-65 times higher than those observed for controlled combustion of waste engine oil, within the range of PCDD/PCDF emission factors determined for open biomass burning, and over 2 orders of magnitude lower than open burning of residential waste (Aurell and Gullet, 2010) and, thus, concerns about eventual dioxin bioaccumulation in seafood were alleviated. The results obtained from the air quality modeling and the use of a screening level assessment also indicate that the cancer risks due to the dioxin emissions from in-situ burns of the Gulf oil spill do not exceed USEPA's cancer risk management guidelines of 1 in 10^{-6} (Schaum et al., 2010). The shoreline dioxin concentration from the in-situ burns would be much less than the measured air concentration in rural locations of the U.S. and, thus, concerns about bioaccumulation in seafood were alleviated.

Flaring

Flaring may be conducted to manage excess gas during an accidental event such as damage to a pipeline. For the DWH event, a flare that burned both oil and gas was employed. Flaring would result in the release of NO_x emissions from the flare. The SO_2 emissions would be dependent on the sulfur content of the crude oil.

Particulate matter from the flare would also affect visibility. Flaring or burning activities upwind of a PSD Class I area, e.g., the Breton National Wilderness Area in the CPA, could adversely affect air quality through increased SO_2 concentrations and reduced visibility. More information about the DWH event flaring is available in **Appendix B**. Impacts to visibility would be temporary and are not expected to impact coastal PSD Class I areas.

In-situ burning and flaring are temporary efforts to limit environmental impact during an accidental spill. Flaring needs to be approved by the BSEE Regional Director. The appropriate agencies would monitor for worker safety. Pollutant concentrations onshore would be expected to be within the NAAQS and flaring would thus not be expected to have onshore impacts.

Dispersants

Dispersants may be applied to break up surface and subsurface oil following an accidental spill. In surface application, aircraft fly over the spill, similar to crop dusting on land, and spray dispersants on the visible oil. Dispersant usage is usually reserved for offshore locations. There is the possibility that the dispersant mist can drift from the site of application to a location where workers or the community are exposed by both skin contact and inhalation. Following the DWH event, USEPA provided the TAGA bus, a mobile laboratory, to perform instantaneous analysis of air in coastal communities. Two ingredients in the COREXIT dispersant were measured. Very low levels of dispersant components were identified. It should be noted that the COREXIT ingredients monitored are also common ingredients in a number of household products. Therefore, their detection onshore does not equate to the detection of dispersants. The USEPA has noted that there is no evidence that dispersant application resulted in a significant impact to onshore air quality. Due to the distance to shore and an assumed accidental spill size of 15,000 bbl, it is unlikely that dispersants would be carried to onshore areas.

The COREXIT ingredients also are common ingredients in a number of household products; the detected ingredients may not be due to dispersants. The USEPA found that there is no evidence that dispersant application resulted in a significant impact in onshore air quality. Two dispersant ingredients were sampled in air; one of the ingredients, 2-butoxyethonal, was only presented in COREXIT 9527.

Odors

An accidental spill could result in odors (USEPA, 2010a). The low levels of pollutants may cause temporary eye, nose, or throat irritation, nausea, or headaches, but the doses are not thought to be high enough to cause long-term harm (USEPA, 2010a). Due to the distance to shore and an assumed accidental spill size of 2,200 bbl, it is unlikely that applied dispersants would drift to onshore areas. The impacts of accidental events are not expected to have significant impacts on onshore air quality. The impacts of accident from catastrophic events are still uncertain.

Summary and Conclusion

Accidental events associated with a CPA proposed action that could impact air quality include spills of oil, natural gas, condensate, and refined hydrocarbons; H_2S release; and fire and could result in the releases of NAAQS air pollutants (i.e., SO_x, NO_x, VOC's, CO, PM_{10}, and $PM_{2.5}$). Response activities that could impact air quality include in-situ burning, the use of flares to burn gas and oil, and the use of dispersants applied from aircraft. Measurements taken during an in-situ burning show that a major portion of compounds was consumed in the burn; therefore, pollutant concentrations would be expected to be within the NAAQS. In a recent analysis of air in coastal communities, low levels of dispersants were identified. These response activities are temporary in nature and occur offshore; therefore, there are little expected impacts from these actions to onshore air quality. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Regulations and NTL's are in place to protect workers from H_2S releases. Other emissions of pollutants into the atmosphere from accidental events as a result of a CPA proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications. The impacts of accidental events are not expected to have significant impacts to onshore air quality. The impacts of catastrophic accidental events are still uncertain.

During the DWH event, a huge number of air samples were collected. Analyses included BETX, PM, H_2S, NAAQS criteria pollutants, and dioxin. According to USEPA, in coastal communities air pollutants from the DWH event were at levels well below those that would cause short-term health problems. The air monitoring conducted to date has not found any pollutants at levels expected to cause long-term harm (USEPA, 2010k). However, questions have been raised concerning the effects of the DWH event on public health and the workers, resulting from the releases of particles and toxic chemicals due to evaporation from the oil spill, flaring, oil burning, and the applications of dispersants; see also **Chapter 4.2.1.23.4**. More recent assessments of worker health have found that exposure levels were generally below occupational exposure limits Air quality impacts include the emission of pollutants from the oil, and the fire emissions that are hazardous to human health had the potential to occur during this accidental event. The effects of some of the pollutants accumulate over a life time and can contribute to diseases that can possibly be fatal years after the exposure. However, extensive personal air sampling to ensure worker safety and onshore air monitoring to ensure public safety showed that levels of pollutant remained within acceptable ranges and that can possibly be fatal (**Appendix B**).

Overall, since loss of well-control events and blowouts are rare events and of short duration, potential impacts to air quality are not expected to be significant except in the rare case of a catastrophic event. The summary of vast amounts of data collected and additional studies will provide more information in the future.

4.2.1.1.4. Cumulative Impacts

Background/Introduction

An impact analysis for cumulative impacts in the CPA on air quality is described in this section. This cumulative analysis summary considers OCS and non-OCS activities that could occur and adversely affect onshore air quality and the Breton National Wilderness Area from OCS sources during the 40-year analysis period.

The activities in the cumulative scenario that could potentially impact onshore air quality include a CPA proposed action and the OCS Program, State oil and gas programs, other major factors influencing offshore environments, onshore non-OCS activities, accidental releases from oil spills, accidental releases of H_2S, natural events (e.g., hurricanes), and a catastrophic oil spill. Because the OCS Program includes both new drilling and production as well as production ending on older wells and platform removal, the level of impacts determined in earlier studies are assumed to adequately represent current conditions as well.

The activities for the OCS Program include the drilling of exploration, delineation, and development wells; platform and pipeline installation; service-vessel trips; flaring; and fugitive emissions. Emissions of pollutants into the atmosphere from the activities associated with the OCS Program are not projected to have significant effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and heights, and the resulting pollutant concentrations. Onshore impacts on air quality from emissions related to OCS activities are estimated to be within PSD Class II allowable increments. In an Agency-funded study, the modeling results indicate that the cumulative impacts to the Breton Wilderness Class I Area are well within the PSD Class I allowable increment (Wheeler et al., 2008). The OCS contribution to the air quality problem in the coastal areas is small.

State oil and gas programs onshore, in territorial seas, and in coastal waters also generate emissions that affect onshore air quality. These emissions are regulated by State agencies and/or USEPA. Reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts and, as a result, constitute minor impacts to onshore air quality.

Other major factors influencing offshore environments, such as sand borrowing and commercial transportation, also generate emissions that can affect air quality. These emissions are regulated by State agencies and/or USEPA. Reductions have been achieved through the use of low sulfur fuels and catalytic reduction and, as a result, constitute minor impacts to onshore air quality.

Other major onshore emission sources from non-OCS activities include power generation, industrial processing, manufacturing, refineries, commercial and home heating, and motor vehicles. The total impact from the combined onshore and offshore emissions would be significant to the ozone nonattainment areas in southeast Texas and the parishes near Baton Rouge, Louisiana.

Portions of the Gulf Coast have ozone levels that exceed the Federal air quality standard. Ozone levels are on a declining trend because of air-pollution control measures that have been implemented by the States. This downward trend is expected to continue as a result of local as well as nationwide air-pollution control efforts. However, more stringent air quality standards have recently been implemented by USEPA, which may result in increasing the number of parishes/counties in the coastal states that are in violation of the Federal ozone standard. The Gulf Coast has significant visibility impairment from anthropogenic emission sources. Area visibility is expected to improve somewhat as a result of regional and national programs to reduce emissions.

A spill could result in the loss of crude oil, crude oil with a mixture of natural gas, or refined fuel. Air quality would be affected by the additional response vessel traffic and volatization of components of the oil and natural gas, if released. Impacts from individual spills would be localized and temporary.

The safety issue related to an accidental release of H_2S is described in **Chapter 3.1.1.9.1**. The same safety precautions and regulations described in a CPA proposed action are applicable to the cumulative scenario. That is, a typical safety zone of several kilometers is usually established in the area around the source or platform where the concentration of H_2S would be greater than 20 ppm. In the event of H_2S releases, a Contingency Plan is required.

The effects of hurricanes on the offshore infrastructures are described in **Chapters 3.1.1.9.3 and 3.3.5.2**. Hurricanes mainly cause damage to offshore infrastructures and pipelines, which may result in an oil spill. A hurricane would cause minor effects on the onshore air quality since air emissions in the event of a hurricane are temporary sources. For the cumulative scenario, the emissions from oil-spill and response and infrastructure repair activities are expected to be the same as a CPA proposed action and to have minimum effects on the onshore air quality.

A survey of large oil-spill events in the past indicates that the long-term effects of an oil spill on human health and the environment are still unknown. The large oil-spill incidents include the *Ixtoc I* oil spill in the Bay of Campeche in the Gulf of Mexico on June 3, 1979; *Exxon Valdez* oil spill in Prince William Sound, Alaska, in 1989; the *Prestige* oil spill in the Atlantic Ocean near Spain in 2002; and the DWH event in the Gulf of Mexico in 2010.

The *Ixtoc* oil-spill accident occurred in the Bay of Campeche of the Gulf of Mexico on June 3, 1979. This oil spill became one of the largest oil spills in history at that time (Jernelöv and Linden, 1981). It was estimated that an average of approximately 10,000-30,000 bbl of oil per day were discharged into the Gulf of Mexico. It was finally capped on March 23, 1980. Ocean currents carried the oil, which reached as far as the Texas coastline. There is no study of the long-term impact of air quality from this oil spill on the human health.

The DWH event occurred in 2010. To assess the effects of the DWH event on human health and the environment, the Institute of Medicine held a workshop, "Assessing the Human Health Effects of the Gulf of Mexico Oil Spill," in New Orleans, Louisiana, on June 22-23, 2010. It was reported that people in the coastal areas show the stresses and strains of living with the effects of the spill on their livelihood and their way of life (McCoy and Salerno, 2010). Due to the volatile chemicals that evaporated from the oil spill into the atmosphere, persons in the coastal areas reported experiencing sickness, fever, coughing, and lethargy. Some of these compounds could have significant effects on human health; however, the long-term effects on exposed persons from DWH emissions are unknown

The global CO_2 emissions in 2010 are estimated to be about 33.0 billion tons (Olivier et al., 2011); the annual CO_2 emissions in the WPA and CPA are 0.34 and 1.3 million tons, respectively. The United States' CO_2 emissions in 2008 were estimated to be 7.1 billion metric tons CO_2 equivalents. The annual CO_2 emissions in the WPA and CPA are 0.34 and 1.3 million tons, respectively. Total OCS contributions including all vessels, such as fishing, commercial, and military vessels, is 0.45 percent of the U.S. total. Specifically, OCS oil and gas sources are 0.4 percent of the U.S. total. The OCS activity is about 0.005 percent of total global CO_2 emissions. Therefore, OCS activity would not contribute significantly to the global warming or climate change. In summary, there are few limited studies of the long-term impact of air quality on human health in the history of oil spills.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with the OCS Program are not projected to have significant effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and mixing heights, and the resulting pollutant concentrations. Reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts, and as a result, such emissions constitute minor impacts to onshore air quality. Onshore impacts on air quality from emissions from OCS activities are estimated to be within PSD Class II allowable increments. The modeling results indicate that the cumulative impacts to the Breton Wilderness Class I Area are well within the PSD Class I allowable increment (Wheeler et al., 2008). The Gulf Coast States' ozone levels are declining because of air-pollution control measures that they have implemented. This downward trend is expected to continue as a result of local as well as nationwide air-pollution control efforts. The Gulf Coast has significant visibility impairment from anthropogenic emission sources. Area visibility is expected to improve somewhat as a result of regional and national programs to reduce emissions.

The incremental contribution of a CPA proposed action (as analyzed in **Chapter 4.2.1.1.2**) to the cumulative impacts would not significantly affect coastal nonattainment areas. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a CPA proposed action would be very small. The cumulative contribution to visibility impairment from a CPA proposed action is also expected to be very small. Area visibility is expected to improve somewhat as a result of regional and national programs to reduce emissions. A CPA proposed action would have an insignificant effect on ozone levels in ozone nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS.

4.2.1.2. Water Quality

For the purposes of this EIS, water quality is the ability of a waterbody to maintain the ecosystems it supports or influences. In the case of coastal and marine environments, the quality of the water is influenced by the rivers that drain into the area, the quantity and composition of wet and dry atmospheric deposition, and the influx of constituents from sediments. Besides the natural inputs, human activity can contribute to diminished water quality through discharges, runoff, dumping, air emissions, burning, and spills. Also, mixing or circulation of the water can either improve the water through flushing or be the source of factors contributing to the decline of water quality.

Evaluation of water quality is done by the measurement of factors that are considered important to the health of an ecosystem. The primary factors influencing coastal and marine environments are temperature, salinity, dissolved oxygen, nutrients, potential of hydrogen (pH), oxidation reduction potential (Eh), pathogens, and turbidity or suspended load. Trace constituents such as metals and organic compounds can affect water quality. The water quality and sediment quality may be closely linked. Contaminants, which are associated with the suspended load, may ultimately reside in the sediments rather than the water column.

The region under consideration is divided into coastal and offshore waters for the following discussion. Coastal waters, as defined by BOEM, include all the bays and estuaries from the Rio Grande River to Florida Bay (**Figure 4-2**). Offshore waters, as defined in this EIS, include both State offshore water and Federal OCS waters, which includes everything outside any barrier islands to the Exclusive Economic Zone. The inland extent is defined by the Coastal Zone Management Act.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this EIS. A summary of those analyses and their reexamination due to new information is presented in the following sections. A brief summary of potential impacts follows. Impacts from routine activities associated with a CPA proposed action would be minimal if all existing regulatory requirements are met. Coastal water impacts associated with routine activities include increases in turbidity resulting from pipeline installation and navigation canal maintenance, discharges of bilge and ballast water from support vessels, and runoff from shore-based facilities. Offshore water impacts associated with routine activities result from the discharge of drilling muds and cuttings, produced water, residual chemicals used during workovers, structure installation and removal, and pipeline placement. The discharge of drilling muds and cuttings causes temporary increased turbidity and changes in sediment composition. The discharge of produced water results in increased concentrations of some metals, hydrocarbons, and dissolved solids within an area of about 100 m (328 ft) adjacent to the point of discharge. Structure installation and removal and pipeline placement disturbs the sediments and causes increased turbidity. In addition, offshore water impacts result from supply and service-vessel bilge and ballast water discharges.

The activity associated with a CPA proposed action would contribute a small percentage of the existing and future OCS energy industry. The specific discharges, drill muds, cuttings and produced water, and accidents resulting in spills would occur in proportion to production and, therefore, could add a small increase to the anticipated impacts. Furthermore, the vessel traffic and related discharges associated with a proposed action are a fraction of the ongoing commercial shipping and military activity in the Gulf. The impacts of discharges, sediment disturbances, and accidental releases are a small percentage of the overall activity and the overall impacts to coastal and offshore waters.

4.2.1.2.1. Coastal Waters

4.2.1.2.1.1. Description of the Affected Environment

The Gulf of Mexico is the ninth largest waterbody in the world (USDOC, NOAA, 2008a). The description of the physical oceanography of the Gulf of Mexico is described in **Appendix A.2**. The United States portion of the Gulf of Mexico region follows the coastline of five states from the southern tip of Texas moving eastward through Louisiana, Mississippi, Alabama, and ending in the Florida Keys

(**Figure 4-2**). The combined coastline of these states totals over 47,000 mi (75,639 km) (when including the shores of all barrier islands, wetlands, inland bays, and inland bodies of water) (USDOC, NOAA, 2008a). The Gulf's coastal areas contain half the wetlands in the United States (USDOC, NOAA, 2008a). Wetlands are discussed in further detail in **Chapter 4.2.1.4**. According to USEPA (2008b), the Gulf Coast coastal area comprises over 750 bays, estuaries, and sub-estuary systems that are associated with larger estuaries. Gulf Coast estuaries and wetlands provide important spawning, nursery, and feeding areas for a wide array of fish wildlife as well as being the home for a wide range of indigenous flora and fauna (USEPA, 2008b). The coastal waters of the Gulf Coast are an extremely productive natural system (USEPA, 2008b), which is also important to the Gulf Coast economy as the major commercial fishing ports in the region yield over 1.2 billion pounds of seafood on an annual basis (USDOC, NOAA, 2008a). The natural resources of the Gulf of Mexico are also important for tourism and recreation.

Over 150 rivers empty out of North America into the Gulf of Mexico (Gore, 1992, p. 127). The river deltas emptying into the Gulf bring freshwater and sediment into coastal waters (Gore, 1992, pp. 127-131), which affects the water quality of receiving waters. Rivers carry excess nutrients downstream (e.g., nitrogen and phosphorus), as well as other possible inputs such as contaminants from industrial wastewater discharge, downstream; this effect is cumulative as the river reaches an estuary (Gore, 1992, pp. 280 and 291). Overenrichment of nutrients may lead to eutrophication that can eventually cause algal blooms and fish kills (Gore, 1992, p. 280) (see below for more information on nutrient enrichment and its effects; also see the wetlands and seagrasses discussions in **Chapters 4.2.1.4 and 4.2.1.5**, respectively). The emptying of rivers into the GOM is part of the hydrologic cycle or water cycle (USDOI, GS, 2010a). Understanding this cycle not only explains the movement of water on Earth but also how water quality might be affected by both natural and anthropogenic sources. The water cycle may introduce chemical and physical factors that alter the condition of the natural water, such as the addition of waterborne pollutants, or the addition of warmer water, into the GOM through waterbodies emptying into the GOM, runoff, groundwater discharge, or precipitation. Water quality in coastal waters of the northern Gulf of Mexico is highly influenced by season. Seasonality influences salinity, dissolved oxygen, nutrient content, temperature, pH and Eh, pathogens, turbidity, metals, and organic compounds. Salinity in open water near the coast may vary between 29 and 32 psu during fall and winter, but it may decline to 20 psu during spring and summer due to increased runoff (USDOI, MMS, 2000a).

The priority water quality issues identified by the Gulf of Mexico Alliance are as follows: (1) reducing risk of exposure to disease-causing pathogens; (2) minimizing occurrence and effects of harmful algal blooms; (3) identifying sources of mercury in Gulf seafood; and (4) improving the monitoring of Gulf water resources (Gulf of Mexico Alliance, 2009a). In addition to water quality itself, nutrients and nutrient impacts are also a regional priority issue for the organization (Gulf of Mexico Alliance, 2009b).

The leading source of contaminants that impair coastal water quality is urban runoff. Urban runoff can include suspended solids, heavy metals and pesticides, oil and grease, nutrients, and organic matter. Urban runoff increases with population growth, and the Gulf Coast region has experienced a 109 percent population growth since 1970, with an additional expected 15 percent increase expected by 2020 (USDOC, NOAA, 2011a). Other pollutant source categories include (1) agricultural runoff, (2) municipal point sources, (3) industrial sources, (4) hydromodification (e.g., dredging), and (5) vessel sources (e.g., shipping, fishing, and recreational boating).

The National Research Council (NRC, 2003, Table I-4, p. 237) estimated that, on average, approximately 26,324 bbl of oil per year entered Gulf waters from petrochemical and oil refinery industries in Louisiana and Texas. Further, NRC (2003) calculated an estimate for oil and grease loads from all land-based sources per unit of urban land area for rivers entering the sea. Based on the size of its watershed, the Mississippi River introduced approximately 3,680,938 bbl of oil and grease per year from land-based sources (NRC, 2003, Table I-9, p. 242) into the waters of the Gulf of Mexico.

Since the marine environment is a dynamic system, sediment quality and water quality can affect each other. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., adsorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are (re)suspended (e.g., due to dredging or a storm event), the resuspension can lead to a temporary redox flux, including a localized and temporal release of any formally sorbed metals as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982).

The overall coastal condition of the Gulf Coast was evaluated from 2001 to 2002 by USEPA and was rated as fair to poor (USEPA, 2008b). Specifically, water quality was rated as fair while sediment quality and the coastal habitat index (a rating of wetlands habitat loss), both of which affect water quality, were rated as poor. The USEPA also conducted similar evaluations from 1990 to 1996 (USEPA, 2001) and again from 1997 to 2000 (USEPA, 2005). Water quality was poor overall in the first Coastal Condition Report, but it increased to fair overall in the latter reports. Conversely, sediment quality was generally fair in the first two reports and decreased to poor in the last report. The Barataria/Terrebonne Estuary, near Port Fourchon, which is a common service base, was ranked fair in terms of water quality (USEPA, 2007b) and was assessed as having moderately high eutrophic conditions by NOAA (Bricker et al., 2007). The Galveston Bay estuary system was ranked poor in terms of water quality and fair to poor in terms of sediment quality (USEPA, 2007b). Galveston Bay was individually characterized as having moderately low eutrophic conditions (Bricker et al., 2007). The estuarine area of the Coastal Bend Bays, which includes Corpus Christi Bay, was ranked fair in terms of water quality and poor in terms of sediment quality (USEPA, 2007b), while Corpus Christi Bay alone was characterized as moderately eutrophic (Bricker et al., 2007).

The NOAA examined additional Gulf Coast estuary systems near the CPA and, of those with sufficient data, the Mississippi/Atchafalaya Plume and Perdido Bay had high overall eutrophic conditions, Barataria Bay had moderate high overall eutrophic conditions, Breton/Chandeleur Sound and Lake Pontchartrain were ranked as having moderate overall eutrophic conditions, the Mississippi River had moderately low overall eutrophic conditions, and Mississippi Sound and Lake Borgne had overall low eutrophic conditions (Bricker et al., 2007).

The passage of hurricanes and tropical storms serves to mix and transport waters. Winds can transport coastal waters to the inner shelf or force waters with higher salinity inland. Winds and waves resuspend bottom sediments, resulting in temporarily elevated levels of suspended solids in the water column. Contaminants sequestered in sediments, for example, tributyltin (an active ingredient in biocides), may be redistributed. Similarly, nutrients in sediments may be reintroduced into the water column and result in increased phytoplankton activity. Physical mixing of the water column by storms can also reoxygenate bottom waters and temporarily alleviate hypoxic conditions, as has been observed on the Louisiana shelf (Walker and Rabalais, 2006).

Hurricanes Katrina and Rita caused extensive flooding and damage to industrial and municipal waste facilities and to residential and commercial structures. Industrial and agricultural chemicals, household chemicals, sewage, oil, and nutrients contained in the flood waters had the potential to degrade water quality in coastal areas. The flood waters of New Orleans contained elevated bacterial levels and were oxygen depleted, but it was generally typical of storm water when pumped into Lake Pontchartrain (Pardue et al., 2005). Testing approximately 1 month following the storm identified low levels of fecal coliform in Mississippi Sound and Louisiana coastal waters (USEPA, 2006). Coast Guard Sector New Orleans received reports that more than 8 million gallons of crude oil were discharged throughout the region (Keel et al., 2008). However, testing approximately 1 month following the hurricanes revealed very few detectable toxics in estuarine or coastal waters resulting from the hurricanes (USEPA, 2006).

The condition of the Gulf Coast was altered by the DWH event and associated oil spill. The Government estimated that approximately 4.9 MMbbl of oil were released from the well during the event (Oil Spill Commission, 2011b) and 1.84 million gallons of dispersant were used to breakup and dilute the oil subsea at the wellhead and on the surface (Oil Spill Commission, 2011c). As well, the corresponding emission of methane from the wellhead during the event was estimated between 9.14×10^{9} and 1.29×10^{10} moles (Kessler et al., 2011; Valentine et al., 2010). In coastal waters, the maximum extent of surface water and shoreline oiling stretched from roughly the Louisiana-Texas border to Apalachicola, Florida (Oil Spill Commission, 2011b, Figure 7.1). As well, a subsurface oil and gas plume was discovered in deep waters between ~1,100 and 1,300 m (3,609 and 4,265 ft) (e.g., Diercks et al., 2010). Based on in-situ fluorescence and oxygen measurements (likely indicators of oil concentration and biodegradation, respectively), the subsurface plume traveled to the northeast of the wellhead and much farther to the southwest, reaching as far west as approximately -93.0° (e.g., Kessler et al., 2011; see supporting online material).

In general, coastal water quality would potentially not only be impacted by the oil, gas, and their respective components from an accidental event but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, hydromodification (e.g., dredging, berm building, etc.) and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree. Fortunately, over time, natural processes can physically, chemically, and biologically degrade oil (NRC, 2003). The physical processes involved include evaporation, emulsification, and dissolution; the primary chemical and biological degradation processes include photooxidation and biodegradation (i.e., microbial oxidation).

The oil that entered the Gulf of Mexico from the DWH event is a South Louisiana sweet crude oil (i.e., it is low in sulfur) (USDOC, NOAA, 2010r). The oil is fairly high in alkanes (organic compounds containing only carbon and hydrogen and single bonds; sometimes called paraffin or aliphatic compounds) (USDOC, NOAA, 2010r). Because alkanes are simple hydrocarbons, these oils are likely to undergo biodegradation more easily (USDOC, NOAA, 2010r). Weathering of crude can occur within the first 24-48 hours with up to a 40 percent weight loss within 7 days (English, 2010). Also, this oil is less toxic than other crude oils in general because this oil is lower in PAH's than many crude oils.

The DWH event released natural gas into the water column in addition to oil. Methane is the primary component of natural gas (Maina, 2005). Limited research is available for the biogeochemistry of hydrocarbon gases in the marine environment (Patin, 1999, p. 233). Theoretically, methane could stay in the marine environment for long periods of time (Patin, 1999, p. 237), as methane is highly soluble in seawater at the high pressures and cold temperatures found in deepwater environments (NRC, 2003, p. 108). Methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974, p. 23). During the DWH event, methane and oxygen distributions were measured at 207 stations throughout the affected region (Kessler et al., 2011). Based on these measurements, it was concluded that, within ~120 days from the onset of release, $\sim 3.0 \times 10^{10}$ to 3.9×10^{10} moles of oxygen were respired, primarily by methanotrophs, and left behind a residual microbial community containing methanotrophic bacteria. The researchers further suggested that a vigorous deepwater bacterial bloom respired nearly all the released methane within this time and that by analogy, large-scale releases of methane from hydrate in the deep ocean are likely to be met by a similarly rapid methanotrophic response. Unfortunately, little is known about methane toxicity in the marine environment, but there is concern as to how methane in the water column might affect fish (**Chapter 4.2.1.18.1**).

Extensive water and sediment sampling was performed in coastal waters during the DWH response. Water and sediment samples were collected in the nearshore zone at multiple sites from Texas to Florida for quantitative analysis of oil and oil-related compounds, dispersants, or by-products (OSAT, 2010). The main nearshore sampling efforts were conducted by USEPA, USGS, and the Center for Toxicology and Environmental Health (a BP contractor), with additional samples provided by other Federal and State agencies. The nearshore sampling plan was designed to determine if the spill had contaminated the sediments and surface waters with oil-related products and/or dispersant-related chemicals. A total of 6,090 water samples were considered for comparison with USEPA's Human Health benchmarks. None of the samples exceeded the USEPA benchmark for human health (child swimmer scenario). A total of 6,909 water and sediment samples were considered for comparison with USEPA's Aquatic Life benchmarks. Of these samples, a total of 41 nearshore water benchmark exceedances were observed throughout the event. Based on oil fingerprinting, 13 of these samples were of indeterminate origin, 19 were considered not consistent with Mississippi Canyon Block 252 oil and 9 were deemed consistent with Mississippi Canyon Block 252 oil. Only a small subset of the analyzed samples targeted areas of observed surface oil, such as samples collected during the Dispersant Environmental Effects Project. A total of 24 nearshore sediment benchmark exceedances were observed throughout the event. As with water, fewer sediment benchmark exceedances were observed in USEPA Region 6 (Texas and Louisiana) than in USEPA Region 4 (Alabama, Mississippi, and Florida). Of the total sediment exceedances, 9 samples were of indeterminate origin, 11 were considered not consistent with Mississippi Canyon Block 252 oil, and 4 were consistent with Mississippi Canyon Block 252 oil. Notably, no water or sediment benchmark exceedances in the nearshore measured after August 3 (the last overflight observation of surface oil) were consistent with Mississippi Canyon Block 252 oil.

One standard tool used in response to spilled oil on water is dispersants. The purpose of chemical dispersants is to facilitate the movement of oil into the water column in order to encourage weathering and biological breakdown of the oil (i.e., biodegradation) (NRC, 2005a; Australian Maritime Safety Authority, 2010). If the oil moves into the water column and is not on the surface of the water, it is less likely to reach sensitive shore areas (USEPA, 2010c). Since sea birds are often on the surface of the water or in shore areas, dispersants are also considered to be very effective in reducing the exposure of sea birds to oil (Australian Maritime Safety Authority, 2010). In addition to dispersion being enhanced by artificial processes, oil may also be dispersed through natural processes. For instance, microbial metabolism of crude oil results in the dispersion of oil (Bartha and Atlas, 1983). Oil dispersion, as a spill-response strategy, has both positive and negative effects. The positive effect is that the oil, once dispersed, is more available to be degraded. The negative effect is that the oil, once dispersed, is more available to microorganisms and temporarily increases the toxicity (Bartha and Atlas, 1983). The toxicity of dispersed oil in the environment depends on many factors, including the effectiveness of the dispersion, temperature, salinity, the degree of weathering, type of dispersant, and degree of light penetration in the water column (NRC, 2005a). The toxicity of dispersed oil is primarily due to the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

COREXIT 9500 and 9527 were used in response to the DWH event and resulting spill (USEPA, 2010c). The components of these dispersants are identical with the exception of the base solvent; COREXIT 9527 has an organic solvent as a base (McDonald et al. 1984; USEPA, 2010c). Dispersants used in the 1960's were quite toxic, but more recently developed dispersants such as COREXIT are considerably less toxic (Doe and Wells, 1978; Leahy and Colwell, 1990). Lindstrom and Braddock (2002) found that environmental use of COREXIT 9500 could result in either increases or decreases in the toxicity of residual oil through selective microbial mineralization of hydrocarbons. In fact, reviews of studies have found that the general effectiveness of dispersants in enhancing biodegradation of crude oil and individual hydrocarbons is highly variable and depends on several factors, including the chemical formulation of the dispersant, its concentration, and the dispersant/oil application ratio (Boehm, 1983). A recent study assessed the impacts of COREXIT EC9500A, which was widely deployed during the DWH event, on microbial communities from a beach impacted by the spill (Hamdan and Fulmer, 2011). In cultured laboratory samples spiked with dispersant, the findings suggest that hydrocarbon-degrading bacteria could be impacted by very high dispersant concentrations (>1 mg/L), with potential implications for the capacity of the environment to bioremediate spills. However, there was evidence that the dispersants worked in dispersing oil at the wellhead in the case of the DWH event (USDOC, NOAA, 2010s; USEPA, 2010c). COREXIT 9527 has been shown to greatly increase volatile liquid hydrocarbons incorporation into water, as well as to accelerate the process in experiments compared with observations where no dispersant was used (McDonald et al. 1984). In fact, dispersants used during the DWH event have been noted to reduce the volatile organic compounds that can be a workplace issue for response workers on ships near the site (White House Press Briefing, 2010). Since the amount of dispersants used for the spill resulting from the DWH event is unprecedented and since this is the first time dispersants have been applied in such quantities on the surface in deep waters, and at the depth of the well itself, continual monitoring and evaluation of their use is imperative to be sure, for example, that hypoxic conditions are not reached in subsurface waters (White House Press Briefing, 2010). Note, however, that hypoxic conditions were not reached during the DWH event in the subsurface plume (e.g., OSAT, 2010).

During the DWH response, sediment and water samples collected in the nearshore zone were analyzed for a number of dispersant-related chemicals, including, but not limited to dipropylene glycol n-butyl ether (DPnB), propylene glycol, and dioctylsulfosuccinate. Between May 13 and October 20, 2010, there were 4,850 water and 412 sediment samples collected in the nearshore zone (OSAT, 2010). None of the concentrations of dispersant-related chemicals found in water samples collected during the response exceeded USEPA's benchmarks. Only 66 samples (60 water and 6 sediment) had detectable levels of dispersant-related chemicals. DPnB was the most common detectable dispersant-compound and was found in 57 of the 60 water samples; however, concentrations never exceeded 3 μg/L (cf. USEPA screening level 1 mg/L). The presence of dispersant-related chemicals in water occurred all along the Gulf Coast; however, a majority of the nearshore detects were encountered around Louisiana. Propylene glycol was the only dispersant-related chemical detected in the sediments. Unfortunately, no benchmark for dispersant indicator compounds in sediment exists; thus, the significance of these concentrations is unknown.

It is currently impossible to estimate precisely the long-term impacts that the spill from the DWH event will have on coastal water quality. Various monitoring efforts and environmental studies are underway. More time is needed to fully assess the impacts of the DWH event. Although response efforts decreased the fraction of oil remaining in Gulf waters and reduced the amount of oil contacting the coastline, oil still remains in the environment (SCAT, 2011a and 2011b; OSAT-2, 2011). As such, there remains some incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on coastal water quality. Much of this information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data on sediments and water quality that have been released, as described above, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives.

4.2.1.2.1.2. Impacts of Routine Events

Background/Introduction

The scenario information related to a CPA proposed action is presented in **Table 3-3**. The routine activities associated with a CPA proposed action that would impact water quality include the following:

- discharges during drilling of exploration and development wells;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- workovers of wells,
- maintenance dredging of existing navigational canals;
- service vessel discharges; and
- nonpoint-source runoff from platforms and OCS Program-related vessels.

Proposed Action Analysis

Sediment disturbance and turbidity may result from nearshore pipeline installation or maintenance dredging. The installation of pipelines can increase the local total suspended solids in the water. The adverse effect on water quality would be temporary and localized. For the nearshore sections of OCS pipelines, COE and State permits for constructing pipelines would require that turbidity impacts be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment. No new navigation channels are expected to be dredged as a result of a CPA proposed action, but a CPA proposed action would contribute to maintenance dredging of existing navigation canals. Maintenance dredging would temporarily increase turbidity levels in the vicinity of the dredging and disposal of materials.

In coastal waters, the water quality would be impacted by the discharges from the service vessels in port. Service-vessel round trips projected for a CPA proposed action are 94,000-168,000 trips over the 40-year life of a proposed action (**Table 3-3**). Based on current service-base usage, it is assumed the majority of these trips would occur in Louisiana's coastal waters. The types of discharges and regulations are discussed in **Chapters 3.1.2.2**. Most discharges are treated or otherwise managed prior to release. In coastal waters, bilge and ballast water may be discharged with an oil content of 15 ppm or less (33 CFR 151.10). The discharges would affect the water quality locally. However, regulations are becoming more stringent. The USCG Ballast Water Management Program became mandatory for some vessels in 2004 (33 CFR 151 Subparts C and D) (USDHS, CG, 2010b). The goal of the program was designed to prevent the introduction of nonindigenous (invasive) species that would affect local water quality. Furthermore, USCG published the Ballast Water Discharge Standard Notice of Proposed Rulemaking in the *Federal Register* on August 28, 2009. Additionally, the final Vessel General Permit, issued by USEPA, became effective on December 19, 2008. This permit is in addition to already existing NPDES permit requirements and now increases the NPDES regulations so that discharges incidental to the normal operation of vessels operating as a means of transportation are no longer excluded unless exempted from NPDES permitting by Congressional legislation (USEPA, 2011d).

Up to one new gas processing plant is projected as a result of a CPA proposed action. In addition, a CPA proposed action would contribute to the use of existing onshore facilities in Louisiana, Mississippi, Alabama, and possibly Texas. These supporting onshore facilities would discharge into local wastewater treatment plants and waterways during routine operations. The types of onshore facilities are discussed in **Chapter 3.1.2.1**. All point-source discharges are regulated by USEPA, the agency responsible for coastal water quality, or the USEPA-authorized State agency. The U.S. Environmental Protection Agency's NPDES storm-water effluent limitation guidelines control storm-water discharges from support facilities. Indirect impacts could occur from nonpoint-source runoff, such as rainfall, which has drained from infrastructure (e.g., a public road or parking lot) and may contribute hydrocarbons, trace-metal pollutants, and suspended sediments. These indirect impacts would be minimal, as long as existing regulations are followed, and difficult to discern from other sources.

Summary and Conclusion

The primary impacting sources to water quality in coastal waters are point-source and storm-water discharges from support facilities, vessel discharges, and nonpoint-source runoff. These activities are not only highly regulated but also localized and temporary in nature. The impacts to coastal water quality from routine activities associated with a CPA proposed action should be minimal because of the distance to shore of most routine activities, USEPA regulations that restrict discharges, and few, if any, new pipeline landfalls or onshore facilities would be constructed.

4.2.1.2.1.3. Impacts of Accidental Events

Background/Introduction

Accidental events associated with a CPA proposed action that could impact coastal water quality include spills of oil and refined hydrocarbons, releases of natural gas, usage of chemical dispersants in oil spill response, spills of chemicals or drilling fluids, loss of well control, collisions, or other malfunctions that would result in such spills. **Chapter 3.2** discusses the accidental events that could result from the impact-producing factors and scenario, with particular attention given to the risk of oil spills, response to such oil spills, loss of well control, pipeline failures, vessel collisions, and chemical and drilling fluid spills. A brief summary is presented here. The impacts of rare, catastrophic spills are discussed in **Appendix B**. A catastrophic event would not be expected to occur in coastal waters because of lower projected production volumes and faster response times, but a catastrophic spill in offshore waters could affect coastal waters.

Proposed Action Analysis

Oil Spills and Natural Gas and Condensate Releases

Water quality is altered and degraded by oil spills through the increase of petroleum hydrocarbons and their various transformation/degradation products in the water. The extent of impact from a spill depends on the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time (**Appendices A.2 and A.3**), as well as human-induced actions for minimizing spill impacts (e.g., the use of chemical dispersants, in-situ burning, and containment booms/skimmers). Crude oils are not a single chemical, but instead are complex mixtures with varied compositions. The various fractions within the crude behave differently in water. Thus, the behavior of the oil and the risk that the oil poses to natural resources depends on the composition of the specific oil encountered (Michel, 1992). Generally, oils can be divided into three groups of compounds, with (1) light-weight, (2) medium-weight, and (3) heavy-weight components. **Chapter 3.2.1** further describes the characteristics of OCS oil and discusses oil spills. Generally, the lighter ends of the oil are more water soluble and would contribute to acute toxicity. As the spill weathers, the aromatic components at the water's surface are more likely to exit the water through evaporation. The heavier fractions are less water soluble and would partition to organic matter. This fraction is more likely to persist in sediments and would contribute to longer-term impacts, depending on variability in physical processes (such as storms), weathering, and biodegradation.

In addition to oil, natural gas may also be explored for or produced in the GOM. Wells and sidetracks (smaller wells drilled as auxiliaries off main wells) may produce a mixture of both oil and natural gas. Condensate is a liquid hydrocarbon phase that generally occurs in association with natural gas. The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. Although there is not a "typical" makeup of natural gas, it is primarily composed of methane (Maina, 2005). Thus, if natural gas were to leak into the environment, methane may be released to the environment. Methane is a carbon source, such as oil, and its introduction into the marine environment could result in lowering dissolved oxygen levels due to microbial degradation. For example, the DWH oil spill resulted in the emission of an estimated 9.14×10^9 to 1.29×10^{10} moles of methane from the wellhead (Kessler et al., 2011; Valentine et al., 2010), with maximum subsurface methane concentrations of 183-315 μm measured in May/June 2010 (Valentine et al., 2010; Joye et al., 2011). This methane release corresponded to a measurable decrease in oxygen in the subsurface plume due to respiration by a community of methanotrophic bacteria; however, hypoxic conditions were never reached (OSAT, 2010). Note that methane released from the DWH was generally confined to the subsurface, with minimal amounts reaching the atmosphere (Kessler et al., 2011; Ryerson et al., 2011b). Unfortunately, little is known about the toxicity of natural gas and its components in the marine environment, but there is concern as to how methane in the water column might affect fish (**Chapter 4.2.1.18**).

The National Academy of Sciences (NRC, 2003), Patin (1999), and Boesch and Rabalais (1987) have reviewed the fate and effects of spilled oil and, to a lesser degree, natural gas releases. **Chapter 3.2.1.7** presents the risk of coastal spills associated with a proposed action. Spills in coastal waters could occur at storage or processing facilities supporting the OCS oil and gas industry or from the transportation of OCS-produced oil through State offshore waters and along navigation channels, rivers, and through coastal bays. For coastal spills, two additional factors that must be considered are the shallowness of the area the spill is in and the proximity to shore. Spills in coastal waters are more likely to be in shallow waters than offshore spills. Spills near the shore are less likely to be diluted since the volume of water in shallow waters is less than in deep waters. Furthermore, spills are more likely to contact land as there is less distance from the spill to land and less time for the oil to weather before it reaches the shore. Since oil does not mix with water and is usually less dense, most of the oil forms a slick at the surface. Small droplets in the water may adhere to suspended sediment and be removed from the water column. Oil may also penetrate sand on the beach or be trapped in wetlands, where it can be re-released into the water some time after the initial spill, such as due to resuspension during storm events.

Oil-Spill Response and Chemical Dispersants

In the case of an accidental event, it is likely that response efforts would reduce the amount of oil. **Chapter 3.2.1.9** provides a further discussion of oil-spill-response considerations. Coastal water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, hydromodification (e.g., dredging, berm building, boom deployment, etc.), and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree.

One standard tool used in response to spilled oil on water is dispersants. Dispersants are not preauthorized for use in coastal areas (NRC, 2005a), but it is possible that the use of dispersants in offshore spills may have effects on coastal environments. The purpose of chemical dispersants is to facilitate the movement of oil into the water column in order to encourage weathering and biological breakdown of the oil (i.e., biodegradation) (NRC, 2005a; Australian Maritime Safety Authority, 2010).

A large volume of chemical dispersants was applied during the DWH oil spill, equaling 1.84 million gallons of dispersant used to breakup and dilute the oil subsea at the wellhead and on the surface (Oil Spill Commission, 2011c). The only dispersant formulation used was the *Corexit*® series, which contains a complex mixture of monomeric and polymeric surfactants including dioctylsulfosuccinate, polyoxyethylene sorbitan mono- and trioleates, and sorbitan monooleates (Getzinger and Ferguson, 2011). While dispersants were not used in the nearshore sampling zone as part of the response, there were concerns that dispersant-related chemicals could be transported into the nearshore zone. Sediment and water samples collected in the nearshore zone were analyzed for a number of dispersant-related chemicals, including, but not limited to dipropylene glycol n-butyl ether (DPnB), propylene glycol, and dioctylsulfosuccinate. Between May and mid-October 2010, there were 4,850 water and 412 sediment samples collected in the nearshore zone (OSAT, 2010). None of the concentrations of dispersant-related chemicals found in water samples collected during the response exceeded USEPA's benchmarks. Only 66 samples (60 water and 6 sediment) had detectable levels of dispersant-related chemicals. The DPnB was the most common detectable dispersant-compound and was found in 57 of the 60 water samples; however, concentrations never exceeded 3 µg/L (cf. USEPA screening level 1 mg/L). The presence of dispersant-related chemicals in water occurred all along the Gulf Coast; however, a majority of the nearshore detects were encountered around Louisiana. Propylene glycol was the only dispersant-related chemical detected in the sediments. Unfortunately, no benchmark for dispersant indicator compounds in sediment exists; thus, the significance of these concentrations is unknown. A recent study assessed the impacts of COREXIT EC9500A, which was widely deployed during the DWH event, on microbial communities from a beach impacted by the spill (Hamdan and Fulmer, 2011). In cultured laboratory samples spiked with dispersant, the findings suggest that hydrocarbon-degrading bacteria could be impacted by very high dispersant concentrations (>1 mg/L), with potential implications for the capacity of the environment to bioremediate spills.

Through the use of dispersants, if the oil moves into the water column and is not on the surface of the water, it is less likely to reach sensitive shore areas (USEPA, 2010c). The toxicity of dispersed oil in the environment depends on many factors, including the effectiveness of the dispersion, temperature, salinity, the degree of weathering, type of dispersant, and degree of light penetration in the water column (NRC, 2005a). The toxicity of dispersed oil is primarily due to the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

Fortunately, over time, natural processes can physically, chemically, and biologically degrade oil (NRC, 2003). The physical processes involved include evaporation, adsorption, emulsification, and dissolution; the primary chemical and biological degradation processes include photooxidation and biodegradation (i.e., microbial oxidation).

Chemical Spills

A study of chemical spills from OCS activities determined that accidental releases of zinc bromide and ammonium chloride could potentially impact the marine environment (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and are not in continuous use; thus, the risk of a spill is small. Most other chemicals are either relatively nontoxic or used in such small quantities that a spill would not result in measurable impacts. Zinc bromide is of particular concern because of the toxic nature of zinc. Close to the release point of an ammonium chloride spill, the ammonia concentrations could exceed toxic levels.

Pipeline Failures

A pipeline failure would result in the release of crude oil, condensate, or natural gas; the impacts of which are discussed above. Pipeline failures are discussed in more detail in **Chapter 3.2.3**.

Fuel Oil Spills from Collisions

A collision may result in the spillage of crude oil, refined products such as diesel or chemicals. Crude oil and chemicals are discussed in the preceding paragraphs. Diesel is the type of refined hydrocarbon spilled most frequently as the result of a collision. Minimal impacts result from a spill since diesel is light and will evaporate, naturally disperse, and/or biodegrade within a few days (USDOC, NOAA, 2006). A collision could result in the release of up to the entire contents of the fuel tanks. Since collisions occur infrequently, the potential impacts to coastal water quality are not expected to be significant.

Summary and Conclusion

Accidental events associated with a CPA proposed action that could impact coastal water quality include spills of oil and refined hydrocarbons, releases of natural gas and condensate, usage of chemical dispersants in oil-spill response, and spills of chemicals or drilling fluids. The loss of well control, pipeline failures, collisions, or other malfunctions could also result in such spills. Although response efforts may decrease the amount of oil in the environment, the response efforts may also impact the environment through, for example, increased vessel traffic, hydromodification, and application of dispersants. Natural degradation processes would also decrease the amount of spilled oil over time. For coastal spills, two additional factors that must be considered are the shallowness of the area and the proximity of the spill to shore. Over time, natural processes can physically, chemically, and biologically degrade oil. Chemicals used in the oil and gas industry are not a significant risk in the event of a spill because they are either nontoxic, used in minor quantities, or are only used on a noncontinuous basis. Spills from collisions are not expected to be significant because collisions occur infrequently.

4.2.1.2.1.4. Cumulative Impacts

Activities in the cumulative scenario that could impact coastal water quality generally include the broad categories of a proposed action and the OCS Program, State oil and gas activity, the activities of other Federal agencies (including the military), natural events or processes, and activities related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). Many of these categories would cause some of the same specific impacts (e.g., vessel traffic would occur for all of those categories except natural processes).

Sediment disturbance and turbidity may result from nearshore pipeline installation, maintenance dredging, disposal of dredge materials, sand borrowing, sediment deposition from rivers, and hurricanes. Turbidity is also influenced by the season. These impacts may be the result of Gulfwide OCS-related activities, State oil and gas activities, the activities of other Federal agencies, and natural processes. Dredging projects related to restoration or flood prevention measures may be directed by the Federal Government for the benefit of growing coastal populations. The COE and State permits would require that the turbidity impacts due to pipeline installation be mitigated by using turbidity screens and other turbidity reduction or confinement equipment. These impacts generally degrade water quality locally and are not expected to last for long periods of time.

Vessel discharges can degrade water quality. Vessels may be service vessels supporting a proposed action, OCS-related activities, or State oil and gas activities. However, the vessels may also be vessels used for shipping, fishing, military activities, or recreational boating. Fortunately, for many types of vessels, most discharges are treated or otherwise managed prior to release through regulations administered by USCG and/or USEPA, and many regulations are becoming more stringent. For example, the USCG Ballast Water Management Program, which was designed to prevent the introduction of invasive species, became mandatory for some vessels in 2004 (33 CFR 151 Subparts C and D) (USDHS, CG, 2010b). Furthermore, USCG published the Ballast Water Discharge Standard Notice of Proposed Rulemaking in the *Federal Register* on August 28, 2009. Additionally, the final Vessel General Permit, issued by USEPA, became effective on December 19, 2008. This permit is in addition to already existing NPDES permit requirements and now increases the NPDES regulations so that discharges incidental to the normal operation of vessels operating as a means of transportation are no longer excluded unless exempted from NPDES permitting by Congressional legislation (USEPA, 2011d). These regulations should minimize the cumulative impacts of vessel activities.

Erosion and runoff from nonpoint sources degrade water quality. Nonpoint-source runoff from onshore support facilities could result from OCS-related activities as well as State oil and gas activities and other industries and coastal development. The leading source of contaminants that impair coastal water quality is urban runoff. Urban runoff can include suspended solids, heavy metals and pesticides, oil and grease, nutrients, and organic matter. Urban runoff increases with population growth, and the Gulf Coast region has experienced a 109 percent population growth since 1970, with an additional expected 15 percent increase by 2020 (USDOC, NOAA, 2011a). The natural emptying of rivers into the GOM as part of the water cycle may introduce chemical and physical factors that alter the condition of the natural water through both natural and anthropogenic sources, such as the addition of waterborne pollutants and inflowing waters of different temperature, as well as inputs to the GOM from groundwater discharge and precipitation. Nutrients carried in waters of the Mississippi River contribute to seasonal formation of the hypoxic zone on the Louisiana-Texas shelf. Recently, USEPA has proposed the first set of nutrient standards; the first set of standards is for the State of Florida (USEPA, 2010l). The proposed new water quality standards would set a series of numeric nutrient (nitrogen and phosphorus) limitations for Florida's lakes, rivers, streams, springs, and canals. The USEPA has regulatory programs designed to protect the waters that enter the Gulf, including regulation of point-source discharges. The USEPA has authorized the Gulf Coast States to administer the State NPDES programs. If these and other water quality programs and regulations continue to be administered and enforced, it is not expected that additional oil and gas activities would adversely impact the overall water quality of the region.

Water quality in coastal waters of the northern Gulf of Mexico is also highly influenced by season. Seasonality influences salinity and dissolved oxygen, nutrient content, temperature, pH and Eh, pathogens, turbidity; metals, and organic compounds.

Since the marine environment is a dynamic system, sediment quality and water quality can affect each other. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., adsorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are (re)suspended (e.g., due to dredging or a storm event), the resuspension can lead to a temporary shift in water quality, including a localized and temporal release of any formally sorbed metals as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982).

Accidental releases of oil, gas, or chemicals would degrade water quality during and after the spill until either the spill is cleaned up or natural processes degrade or disperse the spill. These accidental releases could be a result of a CPA proposed action, ongoing OCS activity, State oil and gas activity, the transport of commodities to ports, and/or coastal industries. The impacts of rare, catastrophic spills are discussed in **Appendix B**. A catastrophic event would not be expected to occur in coastal waters, but a catastrophic spill in offshore waters could affect coastal waters. For example, the DWH oil spill impacted coastal waters and sediments in Louisiana, Mississippi, Alabama, and Florida. The extent of impact from a spill depends on the release location and the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time (**Appendices A.2 and A.3**). The effect on coastal water quality from spills estimated to occur from a CPA proposed action are expected to be minimal relative to the cumulative effects from hydrocarbon inputs from other sources such as river outflow, industrial discharges, and bilge water releases, as discussed in the National Research Council's report *Oil in the Sea* (NRC, 2003).

A major hurricane can result in a greater number of coastal oil and chemical spill events with increased spill volume and oil-spill-response times. In the case of an accidental event, it is likely that response efforts would reduce the amount of oil. **Chapter 3.2.1.9** provides further discussion of oil-spill-response considerations. Coastal water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, hydromodification (e.g., dredging, berm building, boom deployment, etc.) and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree.

Summary and Conclusion

Water quality in coastal waters would be impacted by sediment disturbance and suspension (i.e., turbidity), vessel discharges, erosion, runoff from nonpoint-source pollutants (including river inflows), seasonal influences, and accidental events. These impacts may be a result of a CPA proposed action and the OCS Program, State oil and gas activity, the activities of other Federal agencies (including the military), natural events or processes, or activities related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). The impacts resulting from a CPA proposed action are a small addition to the cumulative impacts on the coastal waters of the Gulf because non-OCS activities, including vessel traffic, erosion, and nonpoint source runoff, are cumulatively responsible for a majority of coastal water impacts. Increased turbidity and discharge from a CPA proposed action would be temporary in nature and minimized by regulations and mitigation. Since a catastrophic OCS Program-related accident would be rare and not expected to occur in coastal waters, the impact of accidental spills is expected to be small. The incremental contribution of the routine activities and accidental events associated with a proposed action to the cumulative impacts on coastal water quality is not expected to be significant.

4.2.1.2.2. Offshore Waters

4.2.1.2.2.1. Description of the Affected Environment

The Gulf of Mexico is the ninth largest waterbody in the world (USDOC, NOAA, 2008a). Over 150 rivers empty out of North America into the Gulf of Mexico (Gore, 1992, p. 127). The majority of this input is accounted for by the two largest United States Deltas, the Mississippi and the 5-river Mobile Bay System (Gore, 1992, p. 127). The river deltas emptying into the Gulf bring freshwater and sediment into coastal waters (Gore, 1992, pp. 127-131), which affects the water quality of receiving waters. Rivers carry excess nutrients (e.g., nitrogen and phosphorus), as well as other possible inputs such as contaminants from industrial wastewater discharge, downstream; this effect is cumulative as the river reaches an estuary (Gore, 1992, pp. 280 and 291). The emptying of rivers into the GOM is part of the hydrologic cycle or water cycle (USDOI, GS, 2010a). Understanding this cycle not only explains the movement of water on Earth but also how water quality might be affected by both natural and anthropogenic sources. The water cycle may introduce components into the GOM through waterbodies emptying into the GOM, runoff, groundwater discharge, or precipitation. Water quality can be affected by not only chemical processes but also by physical and biological processes. For example, the water quality of the Gulf of Mexico is influenced by the physical oceanography of the Gulf of Mexico, which is described in **Appendix A.2**. Besides nutrients, water quality is generally gauged by measuring a series of parameters commonly including, but not limited to, temperature, salinity, dissolved oxygen, pH, Eh, pathogens, and turbidity. Water quality may also examine possible pollutants such as metals and organic compounds.

The water offshore of the Gulf's coasts can be divided into two regions: shallow (<1,000 ft; 305 m) and deep water (>1,000 ft; 305 m). Waters on the continental shelf (0-200 m; 0-656 ft) and slope (200-2,000 m; 656-6,562 ft) are heavily influenced by the Mississippi and Atchafalaya Rivers, the primary sources of freshwater, sediment, nutrients, and pollutants from a huge drainage basin encompassing 55 percent of the continental U.S. (Murray, 1998). The presence or extent of a nepheloid layer, a body of suspended sediment at the sea bottom (Kennet, 1982, p. 524), affects water quality on the shelf and slope. Deep waters east of the Mississippi River are affected by the Loop Current and associated warm-core (anticyclonic) eddies, which consist of clear, low-nutrient water (Muller-Karger et al., 2001). These anticyclonic eddies can entrain and transport high turbidity shelf waters farther offshore over deep Gulf waters. Cold-core cyclonic eddies (counterclockwise rotating) also form at the edge of the Loop Current and are associated with upwelling and nutrient-rich, high-productivity waters. More details on the physical oceanography of the Gulf of Mexico are available in **Appendix A.2**.

Seawater generally averages pH 8 at the surface due to marine systems being buffered by carbonates and bicarbonates. However, in the open waters of the Gulf of Mexico, pH ranges from approximately 8.1 to 8.3 at the surface (Gore, 1992, p. 87). The pH decreases to approximately 7.9 at a depth of 700 m (2,297 ft), and in deeper waters, it increases again to approximately 8.0 (Gore, 1992, p. 87).

The salinity at the sea surface in the offshore central Gulf of Mexico is generally 36 ppt (Gore, 1992, p. 81). Lower salinities are characteristic nearshore where freshwater from the rivers mix with Gulf waters. For example, salinity can decrease to less than 25 ppt near inlets due riverine inputs (Gore, 1992, p. 81). Salinity also varies seasonally. For example, salinity in open water near the coast may vary between 29 and 32 psu during fall and winter but decline to 20 psu during spring and summer due to increased runoff (USDOI, MMS, 2000a) (practical salinity units [psu] are similar to parts per thousand [ppt], but not identical).

Temperatures in the Gulf of Mexico vary seasonally. The average summer surface temperature is approximately 29 ºC (84 ºF) (Gore, 1992, p. 79). In winter, temperature in the northern Gulf is 19 ºC (65 ºF) and in the southern portion of the Gulf, it is about 24 ºC (75 ºF) (Gore, 1992, p. 79). However, temperatures may dip lower during cold fronts. In winter, seawater is well mixed vertically (Gore, 1992, p. 80). At other times, sea-surface temperatures can vary from temperatures at depth. In the summer, warm water may be found from the surface down to a certain depth known as the thermocline. Below this depth, the temperature becomes cooler and therefore the water becomes denser (Gore, 1992, pp. 79-80). In the Gulf, the thermocline may be found anywhere from just below the surface to 160 ft (50 m) deep. Seawater also gets colder in deep water. Below 1,000 m (about 3,300 ft), temperatures are the coldest in the Gulf at <4.4 ºC (40 ºF).

Dissolved oxygen enters the upper waters (~100-200 m; 328-656 ft) of the Gulf of Mexico through the atmosphere and photosynthesis (Jochens et al., 2005). In deep waters, dissolved oxygen is introduced through the transport and mixing of oxygen-rich watermasses into the Gulf of Mexico from the Caribbean Sea through the Yucatan Channel (Jochens et al., 2005). The Gulf of Mexico does not have watermass formation to replenish the deep oxygen concentrations (Jochens et al., 2005). Thus, the deep circulation of the Gulf of Mexico and its related mixing are the mechanisms that replenish the deep oxygen (Jochens et al., 2005). Oxidation of organic matter is the major oxygen sink in the Gulf of Mexico (Jochens et al., 2005). The Gulf of Mexico has an oxygen minimum zone, which is generally located from 300 to 700 m (984 to 2,297 ft) (Jochens et al., 2005).

The zone of hypoxia on the Louisiana-Texas shelf is the largest zone in the United States and the entire western Atlantic Ocean (Turner et al., 2005; **Figure 4-3**). The oxygen-depleted bottom waters occur seasonally and are affected by the timing of the Mississippi and Atchafalaya Rivers' discharges carrying nutrients and freshwater to shelf surface waters. The formation of the hypoxic zone is attributed to a combination of riverborne nutrient inputs supporting phytoplankton growth and shelf stratification, which limits aeration of bottom waters. The hypoxic conditions last until local wind-driven circulation mixes the water again. The areal extent of mid-summer hypoxia has ranged from 40 to 22,000 km^2 (15 to 8,494 mi^2) and averaged approximately 13,500 km^2 (5,212 mi^2) during 1985-2007 (Greene et al., 2009). The 2010 GOM dead zone covered 20,000 km^2 (7,722 mi^2), making it one of the largest ever (LUMCON, 2011). Record spring flooding of the Mississippi River was expected to result in one of the largest recorded hypoxic zones, but the zone was smaller than expected due to strong winds and waves associated with Tropical Storm Don. Variability in mid-summer hypoxic area was modeled using riverine discharge, nitrate loading, and total phosphorus loading and resulted in hypoxia area predictions to within ±30 percent (Greene et al., 2009).

Separate zones of hypoxia have been discovered in other shelf regions. A hypoxic zone was observed 5-15 mi (8-24 km) off the coast of Texas and is likely the result of freshwater inputs generated in Texas and summer upwelling. In 2007, a Texas-created dead zone was discovered and attributed to excessive rainfall and runoff into the Brazos River (LUMCON, 2010). As well, regions of the Mississippi Bight (located just east of the Mississippi River Delta) have been affected by low oxygen bottom waters. For example, a hypoxic zone of 200 km^2 (72 mi^2)was revealed on an August 2006 cruise between the 10- and 20-m isobaths south of Horn and Petit Bois Islands (Brunner, 2007).

The priority, water quality issues identified by the Gulf of Mexico Alliance are as follows: (1) reducing risk of exposure to disease-causing pathogens; (2) minimizing occurrence and effects of harmful algal blooms; (3) identifying sources of mercury in Gulf seafood; and (4) improving the monitoring of Gulf water resources (Gulf of Mexico Alliance, 2009a). In addition to water quality itself, nutrients and nutrient impacts are also a regional priority issue for the organization (Gulf of Mexico Alliance, 2009b).

As with coastal waters, water and sediments on the shelf and slope are greatly affected by runoff. Runoff may include any number of pollutants such as nutrients, pesticides and other organic chemicals, and metals. The National Research Council (2003, Table I-4, p. 237) estimated that, on average, approximately 26,324 bbl of oil per year entered Gulf waters from petrochemical and oil refinery industries in Louisiana and Texas. The Mississippi River introduced approximately 3,680,938 bbl of oil and grease per year from land-based sources (NRC, 2003, Table I-9, p. 242) into the waters of the Gulf of Mexico. As well, shelf waters or sediments off the coast of Louisiana contain variable concentrations of organic pollutants including polynuclear aromatic hydrocarbons (PAH's), herbicides such as Atrazine, chlorinated pesticides, and polychlorinated biphenyls (PCB's), and trace inorganic (metals) pollutants (Turner et al., 2003). The source of these contaminants is primarily the river water that feeds into the area. The concentrations of chlorinated pesticides and PCB's, which are associated with suspended particulates and sediment, continue to decline since their use has been discontinued.

Offshore waters, especially deeper waters, are more directly affected by natural seeps that are located in offshore waters of the Gulf of Mexico. Hydrocarbons enter the Gulf of Mexico through natural seeps in the Gulf of Mexico at a rate of approximately 980,392 bbl per year (a range of approximately 560,224-1,400,560 bbl per year) (NRC, 2003, p. 191). Hydrocarbons from natural seeps are considered to be the highest contributor of petroleum hydrocarbons to the marine environment (NRC, 2003, p. 33). Produced water (formation water) is the largest waste stream by volume from the oil and gas industry that enters Gulf waters. Produced water is commonly treated to separate free oil and is either injected back into the reservoir or discharged overboard according to NPDES permit limits. The NRC has estimated the quantity of oil in produced water entering the Gulf per year to be 473,000 bbl (NRC, 2003, p. 200, Table D-8). These numbers were generated from converting the units reported in the noted reference and do not imply any level of significance.

Since the marine environment is a dynamic system, sediment quality and water quality can affect each other. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., adsorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are (re)suspended (e.g., due to dredging or a storm event), the resuspension can lead to a temporary redox flux, including a localized and temporal release of any formally sorbed metals as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982). However, resuspension events are less likely in deepwater environments. Deepwater sediments, with the exception of barium concentrations in the vicinity of previous drilling, do not appear to contain elevated levels of metal contaminants (USDOI, MMS, 1997 and 2000a). The western Gulf has lower levels of total organic carbon and hydrocarbons in sediment, particularly those from terrestrial sources, than the central Gulf (Gallaway and Kennicutt, 1988). Reported total hydrocarbons, including biogenically derived (e.g., from biological sources), in sediments collected from the Gulf slope range from 5 to 86 nanograms/gram (Kennicutt et al., 1987). Hydrocarbons in sediments have been determined to influence biological communities of the Gulf slope, even when present in trace amounts (Gallaway and Kennicutt, 1988).

A 3-year, environmental baseline study conducted from 1974 to 1977 in the eastern GOM resulted in an overview of the Mississippi, Alabama, and Florida (MAFLA) OCS environment to 200 m (656 ft) (State University System of Florida, Institute of Oceanography, 1977; Dames & Moore, Inc., 1979). Analysis of water, sediments, and biota for hydrocarbons indicated that the MAFLA area is relatively pristine, with some influence of anthropogenic and petrogenic hydrocarbons from river sources. Analysis of trace metal contamination for the trace metals analyzed (barium, cadmium, chromium, copper, iron, lead, nickel, vanadium, and zinc) also indicated no contamination. A decade later, the continental shelf off Mississippi and Alabama was revisited (Brooks, 1991). Bottom sediments were analyzed for high-molecular-weight hydrocarbons and heavy metals. High-molecular-weight hydrocarbons can come from natural petroleum seeps at the seafloor or recent biological production as well as input from anthropogenic sources. In the case of the Mississippi-Alabama shelf, the source of petroleum hydrocarbons and terrestrial plant material is the Mississippi River. Higher levels of hydrocarbons were observed in the late spring, which coincides with increased river influx. The sediments, however, are washed away later in the year, as evidenced by low hydrocarbon values in winter months. Contamination from trace metals was not observed (Brooks, 1991).

Several studies have addressed offshore water and sediment quality in deep waters. Water at depths >1,400 m (4,593 ft) is relatively homogeneous with respect to temperature, salinity, and oxygen (Nowlin, 1972; Pequegnat, 1983; Gallaway et al., 1988; Jochens et al., 2005). Limited analyses of trace metals and hydrocarbons for the water column and sediments exist (Trefry, 1981; Gallaway et al., 1988). Continental Shelf Associates, Inc. (CSA) completed an Agency-funded field study of four drilling sites located in water depths of 1,033-1,125 m (3,389-3,691 ft) (CSA, 2006). The sampling design called for before and after exploratory or development drilling and captured the drilling-related changes that occur in sediments and sediment pore water. Chemical impacts of drilling were detected at all four sites. Impacts noted within the near-field zone included elevated barium, SBF, total organic carbon (TOC) concentrations, and low sediment oxygen levels. At the Viosca Knoll Block 916 site, the closest drilling activity had occurred 1.4 mi (2.3 km) north-northwest and 2 years prior to the study; no drilling had ever been performed at the Viosca Knoll Block 916 site. The site was located at a water depth of 1,125 m (3,691 ft) and 70 mi (120 km) from the mouth of the Mississippi River. At this relatively pristine location, mean concentrations of sediment barium increased by ~30-fold at near-field stations following exploratory drilling (from 0.108% to 3.32%). As well, mean concentrations of sediment mercury and total PAH increased in the near-field from 71 to 90 nanograms/gram and 232 to 279 nanograms/gram, respectively. At this site, sediment cadmium concentrations did not change significantly following exploratory drilling.

The condition of the Gulf Coast was altered by the DWH event and associated oil spill. The Government estimated that approximately 4.9 MMbbl of oil were released from the well during the event (Oil Spill Commission, 2011b) and 1.84 million gallons of dispersant were used to breakup and dilute the oil subsea at the wellhead and on the surface (Oil Spill Commission, 2011c). As well, the corresponding emission of methane from the wellhead during the event was estimated between $9.14x\ 10^{9}$ and $1.29\ x\ 10^{10}$

moles (Kessler et al., 2011; Valentine et al., 2010). In coastal waters, the maximum extent of surface water and shoreline oiling stretched from roughly the Louisiana-Texas border to Apalachicola, Florida (Oil Spill Commission, 2011b, Figure 7.1). As well, a subsurface oil and gas plume was discovered in deep waters between ~1,100 and 1,300 m (3,609 and 4,265 ft) (e.g., Diercks et al., 2010). Based on in-situ fluorescence and oxygen measurements (likely indicators of oil concentration and biodegradation, respectively), the subsurface plume traveled to the northeast of the wellhead and much farther to the southwest, reaching as far west as approximately -93.0° (e.g., Kessler et al., 2011; see supporting online material).

Offshore water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, hydromodification, and the addition of dispersants, methanol, and water-based drilling mud to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree. Fortunately, over time, natural processes can physically, chemically, and biologically degrade oil (NRC, 2003). The physical processes involved include evaporation, emulsification and dissolution; the primary chemical and biological degradation processes include photooxidation and biodegradation (i.e., microbial oxidation).

The oil that entered the Gulf of Mexico from the DWH event is a South Louisiana sweet crude oil (i.e., it is low in sulfur) (USDOC, NOAA, 2010r). The oil is fairly high in alkanes (organic compounds containing only carbon and hydrogen and single bonds, sometimes called paraffin or aliphatic compounds) (USDOC, NOAA, 2010r). Because alkanes are simple hydrocarbons, these oils are likely to undergo biodegradation more easily (USDOC, NOAA, 2010r). Weathering of crude can occur within the first 24-48 hours with up to a 40 percent weight loss within 7 days (English, 2010). Also, this oil is less toxic than other crude oils in general because this oil is lower in PAH's than many crude oils.

The DWH event released natural gas into the water column in addition to oil. Methane is the primary component of natural gas (Maina, 2005). Limited research is available for the biogeochemistry of hydrocarbon gases in the marine environment (Patin, 1999, p. 233). Theoretically, methane could stay in the marine environment for long periods of time (Patin, 1999, p. 237) as methane is highly soluble in sea water at the high pressures and cold temperatures found in deepwater environments (NRC, 2003, p. 108). Methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974, p. 23). During the DWH event, methane and oxygen distributions were measured at 207 stations throughout the affected region (Kessler et al., 2011). Based on these measurements, it was concluded that, within ~120 days from the onset of release, ~3.0×10^{10} to 3.9×10^{10} moles of oxygen were respired, primarily by methanotrophs, and left behind a residual microbial community containing methanotrophic bacteria. The researchers further suggested that a vigorous deepwater bacterial bloom respired nearly all the released methane within this time and that, by analogy, large-scale releases of methane from hydrate in the deep ocean are likely to be met by a similarly rapid methanotrophic response. However, lively debate continues over these findings (Joye et al., 2011; Kessler et al., 2011). Unfortunately, little is known about methane toxicity in the marine environment, but there is concern as to how methane in the water column might affect fish (**Chapter 4.2.1.18.1**).

As in coastal waters, extensive water and sediment sampling was performed in offshore waters by the DWH response (OSAT, 2010). Note that the following is a synthesis of data from the offshore (shelf) and deepwater sampling zones in the OSAT report, separated by the 200-m isobath. Approximately 700 water and 250 sediment samples collected in shelf waters from May through October 2010 were analyzed in the OSAT report. Chronic and acute aquatic life ratios were calculated for all samples in which PAH compounds were analyzed. Six water samples in shelf waters exceeded the USEPA chronic aquatic life benchmark, and one of these exceeded the acute aquatic life benchmark during May-June 2010. No shelf water samples exceeded the benchmark after August 3, 2010. In shelf sediment samples, none of the samples exceeded the USEPA chronic aquatic life benchmark. In the deepwater sampling zone, water and sediment samples were collected by a number of vessels (NOAA, BP contract, and academic) operating both in the vicinity of the wellhead and in the far field. Approximately 4,000 water and sediment samples from the deepwater zone were analyzed in the OSAT report. In the deepwater zone, there was a total of 70 exceedances of aquatic life benchmarks for PAH's in water and 7 exceedances in sediment. Chronic exceedances in water samples in deepwater potentially associated with Mississippi Canyon Block 252 oil were constrained to within approximately 70 km (43 mi) of the wellhead and to approximately two depths (the near-surface and the subsurface between ~1,100 and 1,300 m [3,609 and 4,265 ft]). Quantitative results indicate that deposits of drilling mud-entrained oil remained near the wellhead. Seven sediment samples within 3 km (2 mi) of the wellhead collected since August 3, 2010, exceeded aquatic life benchmarks for PAH's, with oil concentrations of 2,000-5,000 ppm.

One tool that was used in response to the oil leaking into the Gulf of Mexico from the DWH event was dispersants. The purpose of chemical dispersants is to facilitate the movement of oil into the water column in order to encourage weathering and biological breakdown of the oil (i.e., biodegradation) (NRC, 2005a; Australian Maritime Safety Authority, 2010). The amounts of dispersant sprayed at the surface and injected at the wellhead were 1,072,514 gallons and 771,272 gallons, respectively (USDHS, CG, 2010c). The fate of this dispersant remains under study. If the oil moves into the water column and is not on the surface of the water, it is less likely to reach sensitive shore areas (USEPA, 2010c). In addition to dispersion being enhanced by artificial processes, oil may also be dispersed through natural processes. For example, microbial metabolism of crude oil results in the dispersion of oil (Bartha and Atlas, 1983). Dispersion has both positive and negative effects. The positive effect is that the oil, once dispersed, may be more available to be degraded (however, we note that contrary findings for beached oil were presented by Hamdan and Fulmer, 2011). The negative effect is that the oil, once dispersed, has an increased distribution and surface area, increasing the exposure of organisms to oil in the water column (Bartha and Atlas, 1983). Toxicity of dispersed oil in the environment would depend on many factors, including the effectiveness of the dispersion, temperature, salinity, the degree of weathering, type of dispersant, and the degree of light penetration in the water column (NRC, 2005a). The toxicity of dispersed oil is primarily due to the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

A large volume of chemical dispersants was applied during the DWH oil spill, equaling 1.84 million gallons of dispersant used to breakup and dilute the oil subsea at the wellhead and on the surface (Oil Spill Commission, 2011c). The only dispersant formulation used was the *Corexit*® series, which contains a complex mixture of monomeric and polymeric surfactants including dioctylsulfosuccinate, polyoxyethylene sorbitan mono- and trioleates, and sorbitan monooleates (Getzinger and Ferguson, 2011). While dispersants were not used in the nearshore sampling zone as part of the response, there were concerns that dispersant-related chemicals could be transported into the nearshore zone. Sediment and water samples collected in the nearshore zone were analyzed for a number of dispersant-related chemicals, including, but not limited to dipropylene glycol n-butyl ether (DPnB), propylene glycol, and dioctylsulfosuccinate. Between May and mid-October 2010, there were 4,850 water and 412 sediment samples collected in the nearshore zone (OSAT, 2010). None of the concentrations of dispersant-related chemicals found in water samples collected during the response exceeded USEPA's benchmarks. Only 66 samples (60 water and 6 sediment) had detectable levels of dispersant-related chemicals. The DPnB was the most common detectable dispersant-compound and was found in 57 of the 60 water samples; however, concentrations never exceeded 3 µg/L (cf. USEPA screening level 1 mg/L). The presence of dispersant-related chemicals in water occurred all along the Gulf Coast; however, a majority of the nearshore detects were encountered around Louisiana. Propylene glycol was the only dispersant-related chemical detected in the sediments. Unfortunately, no benchmark for dispersant indicator compounds in sediment exists; thus, the significance of these concentrations is unknown. A recent study assessed the impacts of COREXIT EC9500A, which was widely deployed during the DWH event, on microbial communities from a beach impacted by the spill (Hamdan and Fulmer, 2011). In cultured laboratory samples spiked with dispersant, the findings suggest that hydrocarbon-degrading bacteria could be impacted by very high dispersant concentrations (>1 mg/L), with potential implications for the capacity of the environment to bioremediate spills.

COREXIT 9500 and 9527 were used in the DWH event response (USEPA, 2010c). The components of these dispersants are identical, with the exception of the base solvent; COREXIT 9527 has an organic solvent as a base (McDonald et al., 1984; USEPA, 2010c). Dispersants used in the 1960's were quite toxic, but more recently developed dispersants such as COREXIT are considerably less toxic (Doe and Wells, 1978; Leahy and Colwell, 1990). Lindstrom and Braddock (2002) found that environmental use of COREXIT 9500 could result in either increases or decreases in the toxicity of residual oil through selective microbial mineralization of hydrocarbons. In fact, reviews of studies have found that the general effectiveness of dispersants in enhancing biodegradation of crude oil and individual hydrocarbons is highly variable and depends on several factors, including the chemical formulation of the dispersant, its concentration, and the dispersant/oil application ratio (Boehm, 1983). However, there was evidence that the dispersants worked in the case of the DWH event (USDOC, NOAA, 2010s; USEPA, 2010c). COREXIT 9527 has been shown to greatly increase volatile liquid hydrocarbons' incorporation into water as well as to accelerate the process in experiments compared with if no dispersant was used (McDonald et al., 1984). In fact, dispersants used during the DWH event were noted to reduce the volatile organic compounds, which can be a workplace issue for response workers on ships near the site (White House Press Briefing, 2010). Since the amount of dispersants used in the DWH event is unprecedented and since this is the first time dispersants have been applied in deep waters, continual monitoring and evaluation of their use is imperative to be sure, for example, that hypoxic conditions are not reached in subsurface waters (White House Press Briefing, 2010). Note, however, that hypoxic conditions were not reached during the DWH event in the subsurface plume (e.g., OSAT, 2010).

As part of the DWH response, the OSAT (2010) report analyzed results from water and sediment samples analyzed for dispersant-related chemicals collected from June through October 2010. Deepwater samples were analyzed for the dispersant-related chemicals 2-Butoxyethanol, DPnB, and propylene glycol. Screening levels exist for dispersant compounds in water only. The dispersant-related chemical measured predominantly in the deepwater zone was DPnB, with a benchmark for DPnB in water of 1,000 μg/L (1 ppm). Of the 4,114 total water samples that were analyzed for dispersants in deepwater, 353 samples contained measurable amounts of DPnB. The range in detected DPnB concentrations was 0.0170-113.4 μg/L (mean 4.3 μg/L), with all samples significantly below the chronic screening level. Peaks in DPnB detects were observed in two distinct layers, at the surface and in the subsurface (1,100-1,300 m; 3,609-4,265 ft) similar to distributions of exceedances of the aquatic life benchmark for PAH's. Of 440 shelf water samples analyzed, there were no exceedances of dispersant-related benchmarks for individual compounds. Approximately half of these samples did have detections of dispersant-related chemicals. In shelf sediment samples, there was only one detection of a dispersant-related chemical out of 243 samples.

As a result of physical dispersion and/or subsea dispersant injection, subsurface plumes of dispersed oil would likely occur near blowout sites in deep, offshore waters. In a review of deep oil-spill modeling activities, Adams and Socolofsky (2005) concluded that jets of oil and gas will break up into droplets and bubbles upon release from an orifice and that ambient currents (or stratification) may cause formation of subsurface oil and gas plumes. During the DWH event, a subsurface oil and gas plume was first discovered in deep waters between ~1,100 and 1,300 m (3,609 and 4,265 ft) in early May 2010 (Diercks et al., 2010). Dissolved oxygen levels are a concern with any release of a carbon source, such as oil and natural gas, and became a particular concern during the DWH event since dispersants were used in deep waters for the first time. Thus, USEPA required monitoring protocols in order to use subsea dispersants (USDOC, NOAA, 2010s). In areas where plumes of dispersed oil were previously found, dissolved oxygen levels decreased by about 20 percent from long-term average values in the GOM; however, scientists reported that these levels stabilized and were not low enough to be considered hypoxic (USDOC, NOAA, 2010t). The drop in oxygen, which did not continue over time, has been attributed to microbial degradation of the oil. Studies during the spill indicated that bacteria were degrading hydrocarbons from both gas and oil in the subsurface plume, with degradation rates varying based on time and location (Camilli et al., 2010; Hazen et al., 2010; Valentine et al., 2010). Over time, as the oil continued to degrade and diffuse, hypoxia became less of a concern. In fact, the 2010 hypoxic zone could not be linked to the DWH event in either a positive or a negative manner (LUMCON, 2011).

During the DWH event, one of the earlier attempts to stop the oil from leaking from the well was a procedure called a "top kill." The top kill involved using a top kill mud mix that was primarily composed of barite, the heavy mineral used for its mass to hold pressure in the well string, as well as small amounts of other components for hydrate control (Boland, official communication, 2011). This top kill mud mix was really not a "drilling" mud at all, oil-based or water-based, because there was no reason to have lubricating or other qualities needed for drilling as it was simply for weighting to try to contain the blowout. This procedure was not successful and resulted in the release of some mud mix used for this operation. However, BOEM research has shown that drilling mud discharges do not move very far, even when discharged at the surface (CSA, 2006).

It is currently impossible to estimate precisely whether there will be long-term impacts from the DWH spill on offshore water quality. The DWH event and resulting spill occurred in offshore waters and was of considerable magnitude. Various monitoring efforts and environmental studies are underway. Although response efforts decreased the fraction of oil remaining in Gulf waters and reduced the amount of oil contacting the coastline, oil still remains in the offshore environment, albeit at levels that were considered not actionable by USCG (OSAT, 2010). As such, there is incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on offshore water quality. This information includes data and analyses that may be forthcoming after the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the data samples that are available regarding water quality and sediments after the DWH event, as described above, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives.

4.2.1.2.2.2. Impacts of Routine Events

Background/Introduction

The scenario information related to a CPA proposed action is presented in **Table 3-3.** The routine activities associated with a CPA proposed action that would impact water quality include the following:

- discharges during drilling of exploration and development wells;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- workovers of wells,
- maintenance dredging of existing navigational canals;
- service vessel discharges; and
- nonpoint-source runoff.

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The USEPA regulates discharges associated with offshore oil and gas exploration, development, and production activities on the OCS under the Clean Water Act's NPDES program. Regulated wastes include drilling muds, drill cuttings, produced water, production solids such as produced sand, well treatment fluids, well completion fluids, well workover fluids, sanitary wastes, domestic wastes, and miscellaneous wastes (USEPA, 2009b). The U.S. Environmental Protection Agency's NPDES general permit for Region 6 (GMG290000) authorizes discharges from exploration, development, and production facilities located in and discharging to Federal waters of the Gulf of Mexico seaward of the outer boundary of the territorial seas offshore of Louisiana and Texas. The permit was reissued and went into effect on October 1, 2007 (USEPA, 2007a) and will expire on September 30, 2012. This permit covers a large portion of the CPA, as USEPA's regional boundaries do not coincide with BOEM's planning area boundaries. The USEPA Region 4 issues individual and general permits covering facilities that discharge in water depths seaward of 200 m (656 ft) occurring offshore the coasts of Alabama and Florida. The western boundary of the coverage area is demarcated by Mobile and Viosca Knoll lease blocks located seaward of the boundary of the territorial seas from the coasts of Mississippi and Alabama. The USEPA Region 4's NPDES general permit (GMG460000) for offshore oil and gas activities in Federal waters in the eastern portion of the OCS of the Gulf of Mexico (off of the coast of Mississippi and eastward) expired on December 31, 2009 (USEPA, 2009c). The USEPA Region 4 issued the new permit, GEG460000, on March 15, 2010, and it expires on March 21, 2015 (USEPA, 2010m). The changes in the new permit include the following: (1) the permit number; (2) requirements for cooling water intake structures (similar requirements are already in effect in Region 6); (3) best management practices plan requirements to address discharges of debris from blasting and painting activities; (4) clarifications of the testing procedures for determining the degradation of nonaqueous base fluids in a marine, closed-bottle, biodegradation test system; (5) clarifications for the reporting requirements for ratio values used to report compliance with the sediment toxicity and biodegradation tests; and (6) the requirement to perform a seabed survey was deleted since the industry completed this study during the term of the previous permit (USEPA, 2009c). Thus, the permit is similar to the previous permit with the exception of the clarifications and more stringent requirements noted above.

The bulk of waste materials produced by offshore oil and gas activities are produced water (formation water) and drilling muds and cuttings. All of these waste streams are regulated by USEPA through NPDES permits. Characteristics of drilling muds and cuttings, the impacts of discharge, and regulatory controls are discussed in greater detail in **Chapter 3.1.1.4.1**. A CPA proposed action is projected to result in the drilling of a total of 168-329 exploratory and delineation wells and 215-417 development and production wells (**Table 3-3**). Muds are the weighted fluids used to lubricate the drill bit, and cuttings are the ground rock displaced from the well. Drilling muds generally consist of clays, barite, lignite, caustic soda (sodium hydroxide), lignosulfonates, and a base fluid such as freshwater, saltwater, mineral oil, diesel oil, or a synthetic oil (USDOI, BOEMRE, 2010h; NRC, 1983; USEPA, 2009b). However, the exact formulas are complex and vary. Three general types of drilling muds have been used during drilling operations: water-based drilling muds (WBM or WBF), oil-based drilling muds (OBM or OBF), and synthetic-based drilling muds (SBM or SBF). The WBM and WBM-wetted cuttings may be discharged. Historically, the industry has used primarily WBM because they are inexpensive. The OBM's are used to improve drilling performance in difficult situations, such as wells drilled in reactive shales, deep wells, and horizontal and extended-reach wells. The base fluid for OBM is typically diesel or mineral oil. Because these oils often contain toxic materials such as PAH's, the discharge of OBM or cuttings wetted with OBM is prohibited, and these muds are now rarely used in deepwater operations and are only occasionally used on the shelf. The SBM's were developed as a lower-toxicity alternative to OBM and have mostly replaced their use. The base fluid is a synthetic material, typically an olefin or ester, free of toxic PAH's. Discharge of SBM is prohibited and, due to cost, is generally recycled (USEPA, 2009b). However, SBM-wetted cuttings may be discharged after the majority of the SBM has been removed. Water-based muds and cuttings that are discharged increase turbidity in the water column and alter the sediment characteristics in the area where they settle (Neff, 2005). The SBF-wetted cuttings do not disperse as readily in water and descend in clumps to the seafloor (Neff et al., 2000). The SBF on the wetted cuttings gradually breaks down and may deplete the oxygen level at the sediment water interface as it degrades (Neff et al., 2000).

During production, produced water is brought up from the hydrocarbon-bearing strata along with the oil and gas that is generated. Characteristics of produced water, the impacts of discharge, and regulatory controls are discussed in greater detail in **Chapter 3.1.1.4.2**. The scenario for the CPA projects that 215-417 development and production wells would be drilled, of which 81-156 are expected to be producing oil wells and 108-241 are expected to be producing gas wells (**Table 3-3**). Greater volumes of produced water are associated with oil than with gas production. In fact, a report on produced-water volumes in the United States noted that 87 percent of produced water came from oil production (Clark and Veil, 2009). Note, this same report identified that less than 3 percent of total U.S. produced water is generated from Federal offshore activities. Produced water may contain dissolved solids, metals, hydrocarbons, and naturally-occurring radionuclides in higher concentrations than Gulf waters (Veil et al., 2004). Produced water may contain residuals from the treatment, completion or workover compounds used, as well as additives used in the oil/water separation process (Veil et al., 2004). Produced water is treated to meet NPDES requirements before it is discharged. Discharge requirements include required dilution of the produced water. Additional chemical products are used to "workover," treat, or complete a well. These wastes are regulated by USEPA through the NPDES program as noted above. Characteristics of workover, treatment and production chemicals, the impacts of discharge, and regulatory controls are discussed in greater detail in **Chapter 3.1.1.4.3**. Some examples of chemicals that might be used to "workover" or treat a well include, but are not limited to, brines used to protect a well, acids used to increase well production, and miscellaneous products used to separate water from oil, to prevent bacterial growth, or to eliminate scale formation or foaming (Boehm et al., 2001). Completion fluids consist of salt solutions, weighted brines, polymers, and various additives used to prevent damage to the wellbore during operations that prepare the drilled well for hydrocarbon production (USEPA, 2009b).

During structure installation and removal, impacts from anchoring, mooring, pipeline and flowline emplacement, and the placement of subsea production structures may occur. A CPA proposed action is projected to result in the installation of 35-67 structures and the removal of 32-61 structures (**Table 3-3**). A CPA proposed action is also projected to result in the installation of 130-2,075 km (~81-1,289 mi) of pipeline. Additional information on bottom-area disturbance is available in **Chapter 3.1.1.3.2.1**. More specifically, a description of the pipeline installation is provided in **Chapter 3.1.1.3.2**. In the report titled *Brief Overview of Gulf of Mexico OCS Oil and Gas Pipelines: Installation, Potential Impacts, and Mitigation Measures* (Cranswick, 2001), the report states the following:

> According to MMS regulations (30 CFR 250.1003(a)(1)), pipelines with diameters ≥8 5/8 inches that are installed in water depths <200 ft are to be buried to a depth of at least 3 ft below the mudline. The regulations also provide for the burial of any pipeline, regardless of size, if the MMS determines that the pipeline may constitute a hazard to other uses of the OCS; in the GOM, the MMS has determined that all pipelines installed in water depths <200 ft must be buried. The purpose of these requirements is to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. For lines 8 5/8 inches and smaller, a waiver of the burial requirement may be requested and may be approved if the line is to be laid in an area where the character of the seafloor will allow the weight of the line to cause it to sink into the sediments (self-burial). For water depths ≤200 ft, any length of pipeline that crosses a fairway or anchorage in Federal waters must be buried to a minimum depth of 10 ft below mudline across a fairway and a minimum depth of 16 ft below mudline across an anchorage area. Some operators voluntarily bury these pipelines deeper than the minimum.

Any disturbance of the seafloor would increase turbidity in the surrounding water, but the increased turbidity should be temporary and restricted to the area near the disturbance.

Service-vessel discharges include bilge and ballast water and sanitary and domestic waste. A CPA proposed action is projected to result in 94,000-168,000 service-vessel round trips (**Table 3-3**). A marine sanitation device is required to treat sanitary waste generated on the service vessel so that surrounding water would not be impacted by possible bacteria or viruses in the waste (40 CFR 140 and 33 CFR 159). The discharge of treated sanitary waste would still contribute a small amount of nutrients to the water. A description of service-vessel operational wastes is provided in **Chapter 3.1.1.4.10**. Oil may contaminate bilge and, although less likely, ballast water. The regulations for the control of oil discharges are in 33 CFR 151.10. The regulations state that bilge and ballast water may only be discharged with an oil content of less than 15 ppm. The discharges would affect the water quality locally. However, regulations regarding discharges from vessels are becoming increasingly stringent. The USCG Ballast Water Management Program became mandatory for some vessels in 2004 (33 CFR 151 Subparts C and D) (USDHS, CG, 2010b). The program was designed to prevent the introduction of nonindigenous (invasive) species, which would affect local water quality. Furthermore, USCG published the Ballast Water Discharge Standard Notice of Proposed Rulemaking in the *Federal Register* on August 28, 2009. Additionally, the final Vessel General Permit, issued by USEPA, became effective on December 19, 2008. This permit is in addition to already existing NPDES permit requirements and now expands the NPDES regulations so that discharges incidental to the normal operation of vessels operating as a means of transportation are no longer excluded unless exempted from NPDES permitting by Congressional legislation (USEPA, 2011d).

Summary and Conclusion

During exploratory activities, the primary impacting sources to offshore water quality are discharges of drilling fluids and cuttings. During platform installation and removal activities, the primary impacting sources to water quality are sediment disturbance and temporarily increased turbidity. Impacting discharges during production activities are produced water and supply-vessel discharges. Regulations are in place to limit the toxicity of the discharge components, the levels of incidental contaminants in these discharges, and, in some cases, the discharge rates and discharge locations. Pipeline installation can also affect water quality by sediment disturbance and increased turbidity. Service-vessel discharges might include water with oil concentration of approximately 15 ppm as established by regulatory standards. Any disturbance of the seafloor would increase turbidity in the surrounding water, but the increased turbidity should be temporary and restricted to the area near the disturbance. There are multiple Federal regulations and permit requirements that would decrease the magnitude of these activities. Impacts to offshore waters from routine activities associated with a CPA proposed action should be minimal as long as regulatory requirements are followed.

4.2.1.2.2.3. Impacts of Accidental Events

Background/Introduction

Accidental events associated with a CPA proposed action that could impact offshore water quality include spills of oil and refined hydrocarbons, releases of natural gas, usage of chemical dispersants in oil spill response, spills of chemicals or drilling fluids, and loss of well control, collisions, or other malfunctions that would result in such spills. **Chapter 3.2** discusses the accidental events that could result from the impact-producing factors and scenario, with particular attention given to the risk of oil spills, response to such oil spills, loss of well control, pipeline failures, vessel collisions, and chemical and drilling fluid spills. A brief summary is presented here. The impacts of rare, catastrophic spills are discussed in **Appendix B**.

Proposed Action Analysis

Oil Spills and Natural Gas and Condensate Releases

Water quality is altered and degraded by oil spills through the increase of petroleum hydrocarbons and their various transformation/degradation products in the water. Most of the oil spills that may occur as a result of a CPA proposed action are expected to be ≤1 bbl (**Table 3-12**). The extent of impact from a spill depends on the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time (**Appendices A.2 and A.3**), as well as human-induced actions for minimizing spill impacts (e.g., use of chemical dispersants, in-situ burning, and containment booms/skimmers). Crude oils are not a single chemical, but instead are complex mixtures with varied compositions. The various fractions within the crude behave differently in water. Thus, the behavior of the oil and the risk that the oil poses to natural resources depends on the composition of the specific oil encountered (Michel, 1992). Generally, oils can be divided into three groups of compounds, with (1) light-weight, (2) medium-weight, and (3) heavy-weight components. **Chapter 3.2.1** further describes the characteristics of OCS oil and discusses oil spills. Generally, the lighter ends of the oil are more water soluble and would contribute to acute toxicity. As the spill weathers, the aromatic components at the water's surface are more likely to exit the water through evaporation. The heavier fractions are less water soluble and would partition to organic matter. This fraction is more likely to persist in sediments and would contribute to longer-term impacts.

In addition to oil, natural gas may also be explored for or produced in the GOM. Wells and sidetracks (smaller wells drilled as auxiliaries off main wells) may produce a mixture of both oil and natural gas. Condensate is a liquid hydrocarbon phase that generally occurs in association with natural gas. The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. Although there is not a "typical" makeup of natural gas, it is primarily composed of methane (Maina, 2005). Thus, if natural gas were to leak into the environment, methane may be released to the environment. Methane is a carbon source, such as oil, and its introduction into the marine environment could result in lowering dissolved oxygen levels due to increased microbial degradation. For example, the DWH oil spill resulted in the emission of an estimated 9.14×10^9 to 1.29×10^{10} moles of methane from the wellhead (Kessler et al., 2011; Valentine et al., 2010), with maximum subsurface methane concentrations of 183-315 μm measured in May/June 2010 (Valentine et al., 2010; Joye et al., 2011). This methane release corresponded to a measurable decrease in oxygen in the subsurface plume due to respiration by a community of methanotrophic bacteria; however, hypoxic conditions were never reached (OSAT, 2010). Note that methane released from the DWH was generally confined to the subsurface, with minimal amounts reaching the atmosphere (Kessler et al., 2011; Ryerson et al., 2011b). Unfortunately, little is known about the toxicity of natural gas and its components in the marine environment, but there is concern as to how methane in the water column might affect fish (**Chapter 4.2.1.18.1**).

Hydrogen sulfide (H_2S), a toxic gas that is associated with certain formations in the GOM, could be released with natural gas. Depending on the concentration and volume, an H_2S release at the seafloor could negatively impact the water quality as the gas rises to the surface (Patin, 1999). Unlike methane, H_2S is water soluble and can cause hazardous pollution situations in the water environment, such as leading to disturbances in the chemical composition of surface waters, with consequences for human health and biota.

The National Academy of Sciences (NRC, 2003), Patin (1999), and Boesch and Rabalais (1987) have reviewed the fate and effects of spilled oil and, to a lesser degree, natural gas releases. **Chapters 3.2.1.5 and 3.2.1.6** present the risk of offshore spills associated with a proposed action. Oil spills at the water surface may result from a platform accident. Subsurface spills are more likely to occur from pipeline failure or a loss of well control. As noted above, the behavior of a spill depends on many things, including the characteristics of the oil being spilled as well as oceanographic and meteorological conditions. An experiment in the North Sea indicated that the majority of oil released during a deepwater blowout would quickly rise to the surface and form a slick (Johansen et al., 2001). In such a case, impacts from a deepwater oil spill would occur at the surface where the oil is likely to be mixed into the water and dispersed by wind and waves. The oil would undergo natural physical, chemical, and biological degradation processes including weathering. However, data and observations from the DWH event challenged the previously prevailing thought that most oil from a deepwater blowout would quickly rise to the surface. Measurable amounts of hydrocarbons (dispersed or otherwise) were detected in the water column as subsurface plumes and on the seafloor in the vicinity of the release (e.g., Diercks et al., 2010; OSAT, 2010). In the DWH subsurface plume, half-lives were estimated for petroleum hydrocarbons and n-alkanes on the order of 1 month and several days, respectively, indicating the impacts of various weathering processes (Reddy et al., 2011 and references therein). After the *Ixtoc* blowout in 1979, which was located 50 mi (80 km) offshore in the Bay of Campeche, Mexico, some subsurface oil also was observed dispersed within the water column (Boehm and Fiest, 1982); however, the scientific investigations were limited (Reible, 2010). The water quality of offshore waters would be affected by the dissolved components and oil droplets that are small enough that they do not rise to the surface or are mixed down by surface turbulence. In the case of subsurface oil plumes, it is important to remember that these plumes would be affected by subsurface currents, dilution, and natural physical, chemical, and biological degradation processes including weathering.

Oil-Spill Response and Chemical Dispersants

In the case of an accidental event, it is likely that response efforts would reduce the amount of oil in the environment. **Chapter 3.2.1.9** provides a further discussion of oil-spill-response considerations. Offshore water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, top kill attempts involving the use of drilling muds, and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree.

Top kills use drilling muds, which are heavy due to the mineral component barite, in order to stop flow from a well. Top kill methods would typically involve the use of water-based drilling muds, which may be discharged to the ocean under normal operations as regulated by USEPA (USDOI, BOEMRE, 2010h). Depending on the success of the procedure, a portion of the mud could end up on the seafloor since drilling mud discharges do not move far from where they are released (CSA, 2006). See "Accidental Release of Drilling Fluids" below for more information. During the DWH event, a water-based kill mud was used during multiple top kill procedures, which proved unsuccessful. The top kill mud composition was almost all barite, with small amounts of other components for hydrate control.

One standard tool used in response to spilled oil on water is dispersants. The purpose of chemical dispersants is to facilitate the movement of oil into the water column in order to encourage weathering and biological breakdown of the oil (i.e., biodegradation) (NRC, 2005a; Australian Maritime Safety Authority, 2010).

A large volume of chemical dispersants was applied during the DWH oil spill, equaling 1.84 million gallons of dispersant used to breakup and dilute the oil subsea at the wellhead and on the surface (Oil Spill Commission, 2011c). The only dispersant formulation used was the COREXIT® series, which contains a complex mixture of monomeric and polymeric surfactants including the anionic surfactant dioctylsulfosuccinate, polyoxyethylene sorbitan mono- and trioleates, and sorbitan monooleates (Getzinger and Ferguson, 2011). Sediment and water samples collected in the offshore and deepwater zones were analyzed for a number of dispersant-related chemicals, with DPnB as the most commonly detected (OSAT, 2010). Between May and mid-October 2010, a total of 4,916 water and sediment samples were collected in the offshore and deepwater zones. Peaks in DPnB detects were observed in two distinct layers in deep water, at the surface and in the subsurface (1,100-1,300 m; 3,609-4,265 ft), similar to distributions for PAH's. A total of 554 offshore and deepwater samples (552 water and 2 sediment) had detectable levels of dispersant-related chemicals. However, none of the concentrations of dispersant-related chemicals found in water samples collected during the response exceeded USEPA's benchmarks. Only a small subset of the analyzed samples targeted areas of observed surface oil, such as samples collected during the Dispersant Environmental Effects Project. Unfortunately, no benchmark for dispersant indicator compounds in sediment exists; thus, the significance of these concentrations is unknown. Concentrations of the dispersant DPnB in water samples collected during the response decreased significantly with time.

Further research is needed to assess the fate and toxicity of dispersants released in the deep subsurface. For example, benchmarks still need to be set by USEPA for chronic and acute toxicity levels of dispersant-related chemicals in sediments (USEPA, 2010c). Without such benchmarks, it is difficult to assess the impacts of these compounds on marine life in sediments. As well, recent research demonstrated the application of high sensitivity analytical methods to study of dispersant-related compounds in the subsurface plume during the DWH event (Kujawinski et al., 2011). These researchers used ultrahigh-resolution mass spectrometry and liquid chromatography with tandem mass spectrometry (LC/MS/MS) to identify and quantify one key ingredient of the dispersant, dioctylsulfosuccinate. They showed that dioctylsulfosuccinate was sequestered in deepwater hydrocarbon plumes at 1,000-1,200 m (3,281-3937 ft) water depth and persisted up to 300 km (186 mi) from the well, 64 days after deepwater dispersant applications ceased. Note that the concentrations they observed were below those tested in published toxicology assays (e.g., NRC, 2005a). Based on observed concentrations, the researchers concluded that dioctylsulfosuccinate underwent negligible, or slow, rates of biodegradation in the affected waters. These preliminary findings point to the need for further dispersant degradation studies, as well as assessment of the fates and reactivities of the other dispersant-related compounds..

Through the use of dispersants, if the oil moves into the water column and is not on the surface of the water, it is less likely to reach sensitive shore areas (USEPA, 2010c). The toxicity of dispersed oil in the environment would depend on many factors, including the effectiveness of the dispersion, temperature, salinity, the degree of weathering, type of dispersant, and the degree of light penetration in the water column (NRC, 2005a). The toxicity of dispersed oil is primarily due to the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

In addition to response efforts, the natural environment can attenuate some oil. The Gulf of Mexico has numerous natural hydrocarbon seeps, as discussed in **Chapter 3.1.1.7.1**. Thus, the marine environment can be considered adapted to handling small amounts of oil released over time. Furthermore, over time, natural processes can physically, chemically, and biologically degrade oil (NRC, 2003). The physical processes involved include evaporation, adsorption, emulsification, and dissolution; the primary chemical and biological degradation processes include photooxidation and biodegradation (i.e., microbial oxidation).

Chemical Spills

A study of chemical spills from OCS activities determined that accidental releases of zinc bromide and ammonium chloride could potentially impact the marine environment (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and are not in continuous use; thus, the risk of a spill is small. Most other chemicals are either relatively nontoxic or used in such small quantities that a spill would not result in measurable impacts. Zinc bromide is of particular concern because of the toxic nature of zinc. Close to the release point of an ammonium chloride spill, the ammonia concentrations could exceed toxic levels.

Accidental Releases of Drilling Fluids

Drilling muds or fluids are the weighted fluids used to lubricate the drill bit. Drilling muds generally consist of clays, barite, lignite, caustic soda (sodium hydroxide), lignosulfonates, and a base fluid such as freshwater, saltwater, mineral oil, diesel oil, or a synthetic oil (USDOI, BOEMRE, 2010h; NRC, 1983;

USEPA, 2009a); however, the exact formulas are complex and vary. The impacts of discharge and regulatory controls of drilling muds are discussed in great detail in Chapter 3.1.1.4.1. Three general types of drilling muds are used during drilling operations: predominantly water-based drilling muds (WBM or WBF) and synthetic-based drilling muds (SBM or SBF), and less frequently oil-based drilling muds (OBM or OBF). Accidental releases of drilling fluids would have similar effects as discharges. In general, Continental Shelf Associates, Inc.'s research has shown that drilling mud discharges do not move very far even when discharged at the surface (CSA, 2006); therefore, accidental releases of drilling muds are not expected to move very far either. The WBM's may be discharged, but those discharges are regulated by the USEPA through NPDES permits. The WBM's that are discharged increase turbidity in the water column and alter the sediment characteristics in the area where they settle (Neff, 2005). The base mud for OBM is typically diesel or mineral oil. Because these oils often contain toxic materials such as PAH's, the discharge of OBM or cuttings wetted with OBM is prohibited. Thus, an accidental release of OBM's could decrease water and sediment quality locally. The SBM's were developed as an alternative to OBM and, thus, the use of OBM's has been decreasing. The base fluid is a synthetic material, typically an olefin or ester, free of toxic PAH's. Discharge of SBM itself is prohibited and, due to cost, is generally recycled (USEPA, 2009b). However, SBM-wetted cuttings may be discharged after the majority of the SBM has been removed. The SBF-wetted cuttings do not disperse as readily in water and descend in clumps to the seafloor (Neff et al., 2000). The SBF on the wetted cuttings gradually breaks down and may deplete the oxygen level at the sediment water interface as it degrades (Neff et al., 2000). An accidental release of SBF is expected to behave similarly with the SBF sinking to the seafloor adjacent to the release site and resulting in local anoxic conditions.

Pipeline Failures

A pipeline failure would result in the release of crude oil, condensate, or natural gas, the impacts of which are discussed above. Pipeline failures are discussed in more detail in **Chapter 3.2.3**.

Fuel Oil Spills from Collisions

A collision may result in the spillage of crude oil, refined products such as diesel, or chemicals. Crude oil and chemicals are discussed in the preceding paragraphs. Diesel is the type of refined hydrocarbon spilled most frequently as the result of a collision. Minimal impacts result from a spill since diesel is light and will evaporate, naturally disperse, and/or biodegrade within a few hours to a few days (USDOC, NOAA, 2006). Impacts can be more serious when heaver oil is spilled, resulting in a submerged spill and oil-contaminated sediments (Lehmann, 2006). This can occur when oil submerges as a function of its inherent mass relative to that of the receiving water or when oil submerges as a function of its inherent mass plus sediment. An example of such a spill occurred on November 11, 2005, in the Gulf of Mexico when the double-hull tank barge DBL 152 collided with the submerged remains of a pipeline service platform that collapsed during Hurricane Rita. The barge was carrying approximately 119,793 bbl (5,031,306 gallons) of a blended mixture of low API gravity (4.5) slurry oil, and as a result of the incident, the bulk of the released oil sank to the bottom (USDOC, NOAA and ENTRIX, 2009). Since collisions occur infrequently (USDOI, BOEMRE, 2011b), the potential impacts to offshore water quality are not expected to be significant.

Loss of Well Control

A loss of well control is the uncontrolled flow of a reservoir fluid that may result in the release of gas, condensate, oil, drilling fluids, sand, or water. The impacts of the release of gas, condensate, oil, and drilling fluids are discussed above. A loss of well control includes events with no surface expression or impact on water quality and events with a release of oil or drilling fluids. A loss of well control event may also result in localized suspension of sediments, thus affecting water quality temporarily. Loss of well control is a broad term that includes very minor well-control incidents up to the most serious well-control incidents (**Appendix B**). Historically, most losses of well control have occurred during development drilling operations, but losses of well control can happen during exploratory drilling, production, well completions, or workover operations. Although losses of well control are an occasional occurrence during operations on the OCS, only a few of these incidents lead to condensate/crude oil spillage (USDOI, BOEMRE, AIB, 2011). During the period 1971-2009, 41,514 wells were drilled on the

OCS and 249 well control incidents occurred, 50 of which resulted in the spillage of condensate/crude oil. These spills ranged from minor to medium in size (<1 bbl to 450 bbl). The total spilled from these 50 incidents was 1,829 bbl or approximately 0.00001147 percent of the volume produced during this period. Blowouts are a loss of well control subset of more serious incidents, with a greater risk of oil spill or human injury. It is through the loss of well control that the volume and duration of a catastrophic oil spill could occur as was the case with the DWH event. From 1971 to 2010, one well control incident resulted in a spill volume of 1,000 bbl or more and that was the DWH event (USDOI, BOEMRE, AIB, 2011). Although there is an extremely low probability of a catastrophic spill event, the impacts of such an event on water quality are addressed in **Appendix B**. Overall, since major losses of well control and blowouts are rare events, potential impacts to offshore water quality are not expected to be significant except in the rare case of a catastrophic event.

Summary and Conclusion

Accidental events associated with a CPA proposed action that could impact offshore water quality include spills of oil and refined hydrocarbons, releases of natural gas and condensate, usage of chemical dispersants in oil-spill response, spills of chemicals or drilling fluids, loss of well control, pipeline failures, collisions, or other malfunctions that would result in such spills. Spills from collisions are not expected to be significant because collisions occur infrequently. Overall, loss of well control events and blowouts are rare events and of short duration, so potential impacts to offshore water quality are not expected to be significant except in the rare case of a catastrophic event (**Appendix B**). Although response efforts may decrease the amount of oil in the environment, the response efforts may also impact the environment through, for example, increased vessel traffic and application of dispersants. Natural physical, chemical, and biological processes would decrease the amount of spilled oil over time through dilution, weathering, and degradation of the oil (NRC, 2003). Chemicals used in the oil and gas industry are not a significant risk for a spill because they are either nontoxic, used in minor quantities, or are only used on a noncontinuous basis. Although there is the potential for accidental events, a CPA proposed action would not significantly change the water quality of the Gulf of Mexico over a large spatial or temporal scale.

4.2.1.2.2.4. Cumulative Impacts

Activities in the cumulative scenario that could impact offshore water quality generally include the broad categories of a proposed action and the OCS Program, the activities of other Federal agencies (including the military), natural events or processes, State oil and gas activity, and activities related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). Although some of these impacts are likely to affect coastal areas to a greater degree than offshore waters, coastal pollutants that are transported away from shore would also affect offshore environments. Many of these categories noted above would have some of the same specific impacts (e.g., vessel traffic would occur for all of these categories listed above except natural processes).

Sediment disturbance and turbidity may result from pipeline installation, installation and removal of platforms, discharges of muds and cuttings from drilling operations, disposal of dredge materials, sand borrowing, sediment deposition from rivers, and hurricanes. Turbidity is also influenced by the season. In offshore waters, these impacts may be the result of Gulfwide, OCS-related activities by other Federal agencies, including the military, and natural processes. State oil and gas activities may have some effect if they take place near offshore waters. Dredging projects related to restoration or flood prevention measures may be directed by the Federal Government for the benefit of growing coastal populations. These impacts generally degrade water quality locally and are not expected to last for long time periods. Furthermore, discharges from drilling platforms are regulated by USEPA through the NPDES permit process; thus, effects from these discharges should be limited.

Vessel discharges can degrade water quality. Vessels may be service vessels supporting a CPA proposed action, OCS-related activities, or State oil and gas activities. However, the vessels may also be vessels used for shipping, fishing, military activities, or recreational boating. State oil and gas activities, fishing, and recreational boating would have fewer effects on offshore waters except for larger fishing operations and cruise lines, as smaller vessels tend to remain near shore. Fortunately, for many types of vessels, most discharges are treated or otherwise managed prior to release through regulations administered by USCG and/or USEPA, and many regulations are becoming more stringent. For example, the USCG Ballast Water Management Program, which was designed to prevent the introduction of invasive species, became mandatory for some vessels in 2004 (33 CFR 151 Subparts C and D) (USDHS, CG, 2010b). Furthermore, USCG published the Ballast Water Discharge Standard Notice of Proposed Rulemaking in the *Federal Register* on August 28, 2009. Additionally, the final Vessel General Permit, issued by USEPA, became effective on December 19, 2008. This permit is in addition to already existing NPDES permit requirements and now increases the NPDES regulations so that discharges incidental to the normal operation of vessels operating as a means of transportation are no longer excluded unless exempted from NPDES permitting by Congressional legislation (USEPA, 2011d). These regulations should minimize the cumulative impacts of vessel activities.

Erosion and runoff from point and nonpoint sources degrade water quality. Nonpoint-source runoff from onshore support facilities could result from OCS-related activities as well as State oil and gas activities and other industries and coastal development. Although offshore waters would not be affected as strongly as coastal waters since contaminants would be more diluted by the time they reached offshore areas, in many cases this runoff would still contribute somewhat to the degradation of offshore waters. Urban runoff can include suspended solids, heavy metals and pesticides, oil and grease, nutrients, and organic matter. Urban runoff increases with population growth, and the Gulf Coast region has experienced a 109 percent population growth since 1970, with an additional expected 15 percent increase by 2020 (USDOC, NOAA, 2011a). The National Research Council (2003, Table I-4, p. 237) estimated that, on average, approximately 26,324 bbl of oil per year entered Gulf waters from petrochemical and oil refinery industries in Louisiana and Texas. **Chapter 3.1.1.7** discusses the various sources of petroleum hydrocarbons that can enter the Gulf of Mexico in further detail. The natural emptying of rivers into the GOM as part of the water cycle may introduce chemical and physical factors that alter the condition of the receiving waters. The Mississippi River introduced approximately 3,680,938 bbl of oil and grease per year from land-based sources (NRC, 2003, Table I-9, p. 242) into the waters of the Gulf. Nutrients carried in waters of the Mississippi River contribute to seasonal formation of the hypoxic zone on the Louisiana-Texas shelf. Recently, USEPA has proposed the first set of nutrient standards, which are for the State of Florida (USEPA, 2010l). The proposed new water quality standards would set a series of numeric nutrient (nitrogen and phosphorus) limitations for Florida’s lakes, rivers, streams, springs, and canals. The USEPA also regulates point-source discharges. The USEPA has various regulatory programs designed to protect the waters that enter the Gulf. If these and other water quality programs and regulations continue to be administered and enforced, it is not expected that additional oil and gas activities would adversely impact the overall water quality of the region.

Offshore waters, especially deeper waters, are more directly affected by natural seeps since the natural seeps in the Gulf of Mexico are located in offshore waters. Natural seeps are the result of natural processes. Hydrocarbons enter the Gulf of Mexico through natural seeps at a rate of approximately 980,392 bbl/yr (a range of approximately 560,224-1,400,560 bbl/yr) (NRC, 2003, p. 191). Hydrocarbons from natural seeps are considered to be the highest contributor of petroleum hydrocarbons to the marine environment (NRC, 2003, p. 33). However, studies have shown that benthic communities are often acclimated to these seeps and may even utilize them to some degree (NRC, 2003, references therein and p. 33).

Discharges from exploration and production activities can degrade water quality in offshore waters. The USEPA regulates discharges associated with offshore oil and gas exploration, development, and production activities on the OCS under the Clean Water Act’s NPDES program. Regulated wastes include drilling fluids, drill cuttings, deck drainage, produced water, produced sand, well treatment fluids, well completion fluids, well workover fluids, sanitary wastes, domestic wastes, and miscellaneous wastes (USEPA, 2009b). The bulk of waste materials produced by offshore oil and gas activities are produced water (formation water) and drilling muds and cuttings. Produced water is the largest waste stream by volume from the oil and gas industry that enters Gulf waters. The NRC has estimated the quantity of oil in produced water entering the Gulf per year to be 11,905 bbl of oil contributed from 473,000,000 bbl of produced water, with a resulting oil and grease discharge of approximately 11,905 bbl per year (NRC, 2003, p. 200, Table D-8). However, produced water is commonly treated to separate free oil and, as noted above, is a regulated discharge. Since discharges from drilling and production platforms are regulated by USEPA through the NPDES permit process, the effects from these discharges should be limited.

Since the marine environment is a dynamic system, sediment quality and water quality can affect each other. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., adsorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are (re)suspended (e.g., due to a storm event), the resuspension can lead to a temporary redox flux, including a localized and temporal release of any formally sorbed metals as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982).

Accidental releases of oil, gas, or chemicals would degrade water quality during and after the spill until either the spill is cleaned up or natural processes degrade or disperse the spill. These accidental releases could be a result of a CPA proposed action, ongoing OCS activity, State oil and gas activity, the transport of commodities to ports, and/or coastal industries. Actions taking place directly in offshore waters would generally have more significant impacts on offshore waters. The impacts of rare, catastrophic spills are discussed in **Appendix B**. In the case of the DWH oil spill, large regions of surface and subsurface waters in the CPA were impacted, and the long-term impacts of the spill are still being assessed. The extent of impact from a spill depends on the location of release and the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time (**Appendices A.2 and A.3**). **Chapter 4.2.1.2.2.3** contains more information on accidental releases. A major hurricane can result in a greater number of spill events, with increased spill volume and oil-spill-response times. In the case of an accidental event, it is likely that response efforts would reduce the amount of oil. See **Chapter 3.2.1.9** for further discussion of oil-spill-response considerations. Offshore water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree.

Summary and Conclusion

Water quality in offshore waters may be impacted by sediment disturbance and suspension (i.e., turbidity), vessel discharges, erosion and runoff of nonpoint-source pollutants (including river inflows), natural seeps, discharges from exploration and production activities, and accidental events. These impacts may be a result of a CPA proposed action and the OCS Program, the activities of other Federal agencies (including the military), private vessels, and natural events or processes. To a lesser degree, these impacts may also be a result of State oil and gas activity or activities or related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). Routine activities that increase turbidity and discharges are temporary in nature and are regulated; therefore, these activities would not have a lasting adverse impact on water quality. In the case of a large-scale spill event, degradation processes in both surface and subsurface waters would decrease the amount of spilled oil over time through natural processes that can physically, chemically, and biologically degrade oil (NRC, 2003). The impacts resulting from a CPA proposed action are a small addition to the cumulative impacts on the offshore waters of the Gulf, when compared with inputs from natural hydrocarbon inputs (seeps), coastal factors (such as erosion and runoff), and other non-OCS industrial discharges. The incremental contribution of the routine activities and accidental discharges associated with a CPA proposed action to the cumulative impacts on offshore water quality is not expected to be significant.

4.2.1.3. Coastal Barrier Beaches and Associated Dunes

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this section. A summary of those analyses and their reexamination due to new information is presented in the following sections. A brief summary of potential impacts follows. Routine activities associated with a CPA proposed action, such as increased vessel traffic, maintenance dredging of navigation canals, and pipeline installation, would cause negligible impacts and would not deleteriously affect coastal barrier beaches and associated dunes. Indirect impacts from routine activities are negligible and indistinguishable from direct impacts of onshore activities. The potential impacts from accidental events, primarily oil spills, associated with a CPA proposed action are anticipated to be minimal. The incremental contribution of a CPA proposed action to the cumulative impacts to coastal barrier beaches and associated dunes is expected to be small.

4.2.1.3.1. Description of the Affected Environment

The U.S. Gulf shoreline from the Mexican border to Florida is about 1,500 km (932 mi) long. Ocean wave intensities around the Gulf are generally low to moderate. These shorelines are usually sandy beaches that can be divided into several interrelated environments. Generally, beaches consist of a shoreface, foreshore, and backshore. The shoreface slopes downward and seaward from the low-tidal water line, under the water. The nonvegetated foreshore slopes up from the ocean to the beach berm-crest. The backshore is found between the beach berm-crest and the dunes, and it may be sparsely vegetated. The berm-crest and backshore may occasionally be absent due to storm activity.

The dune zone of a barrier landform can consist of a single low dune ridge, several parallel dune ridges, or a number of curving dune lines that may be stabilized by vegetation. These elongated, narrow landforms are composed of wind-blown sand and other unconsolidated, predominantly coarse sediments.

Sand dunes and shorelines conform to environmental conditions found at its site. These conditions usually include waves, currents, wind, and human activities. When Gulf waters are elevated by storms, waves are generally larger and can overwash lower coastal barriers, creating overwash fans or terraces behind and between the dunes. With time, opportunistic plants reestablish on these flat, sand terraces, followed by the usual vegetative succession for this area. Along more stable barriers, where overwash is rare, the vegetative succession in areas behind the dunes is generally complete. Vegetation in these areas of broad flats or coastal strands consists of scrubby woody vegetation, marshes, and maritime forests. Saline and freshwater ponds may be found among the dunes and on the landward flats. Landward, these flats may grade into wetlands and intertidal mud flats that fringe the shore of lagoons, islands, and embayments. In areas where no bay or lagoon separates barrier landforms from the mainland, the barrier vegetation grades into scrub or forest habitat of the mainland.

Larger changes to barrier landforms are primarily due to storms, subsidence, deltaic cycles, longshore currents, and human activities. Barrier landform configurations continually change, accreting and eroding, in response to prevailing and changing environmental conditions. Landform changes can be seasonal and cyclical, such as seen with the onshore movement of sand during the summer and offshore movement during the winter, which is due to seasonal meteorological and wave-energy differences. Noncyclical changes in landforms can be progressive, causing landform movement landward, seaward, or laterally along the coast.

Lateral movement of barrier landforms is of particular importance. As headlands and beaches erode, their sediments are transported offshore or laterally along the shoreline. Eroding headlands typically extend sand spits that may enclose marshes or previously open, shallow Gulf waters. By separating inshore waters from Gulf waters and slowing the dispersal of freshwater into the Gulf, movements of barrier landforms contribute to the area and diversity of estuarine habitat along a coast. Most barrier islands around the Gulf are moving laterally to some degree. Where this occurs, the receding end of the island is typically eroding; the leading end accretes. These processes may be continuous or cyclic.

Accumulations and movements of sediments that make up barrier landforms are often described in terms of regressive and transgressive sequences. Transgressive landforms dominate around the GOM. A transgressive sequence moves the shore landward, allowing marine deposits to form on terrestrial sediments. Transgressive coastal landforms around the Gulf have low profiles and are characterized by narrow widths; low, sparsely vegetated, and discontinuous dunes; and numerous, closely spaced, active washover channels. Landward movement or erosion of a barrier shoreline may be caused by any combination of the following factors: subsidence, sea-level rise, storms, channels, groins, seawalls, and jetties. Movement of barrier systems is not a steady process because the passage rates and intensities of cold fronts and tropical storms, as well as intensities of seasons, are not constant (Williams et al., 1992). A regressive sequence deposits terrestrial sediments over marine deposits, building land into the sea, as would be seen during deltaic land-building processes. Regressive barriers have high and broad dune profiles. These thick accumulations of sand may form parallel ridges.

The coastal environments discussed here are those barrier beaches, wetlands, and submerged vegetation that might be impacted by activities resulting from a CPA proposed action. Geographically, the discussion covers coastal areas that range from the Texas/Louisiana border through Alabama. Several geologic subareas are found along this coast and they vary biologically. The environmental descriptions of this coast are organized into three geologic subareas: (1) the larger western portion of the Chenier Plain that extends into eastern Texas and western Louisiana; (2) the Mississippi River Delta complex of southeastern Louisiana; and (3) the barrier-island and Pleistocene Plain complex of Mississippi and Alabama. The landmasses in these areas are relatively low, so some form broad flat plains with gradually sloping topographies. Tides there are diurnal and micro-tidal. Tidal influences can be seen 25-40 mi (40-64 km) inland in some areas of Texas, Louisiana, Mississippi, and Alabama due to large bay complexes, channelization, and low topographies. Wind-driven tides are often dominant over the minimal gravity tides that occur there.

The descriptive narrative for these resources in the CPA that follows reflects the post-storm and post-DWH spill status of these resources. Barrier island and barrier beach formation are summarized in the sections that follow.

The current discussion of the DWH event includes the identification of resources exposed to oil and to what degree these resources were oiled based on available data. The information discussed is based on information from the Shoreline Cleanup Assessment Team (SCAT) maps and reports that were publicly available (OSAT, 2010 and OSAT-2, 2011); newspaper interviews; scientific magazines; and public, State, and Federal resource agency *Deepwater Horizon* oil-spill-response sites available on the Internet. Areas that have had oil exposure are identified, as these are part of the existing condition of the resource. No assumptions as to health of the resource are made here since monitoring and studies are ongoing. The discussions relating to the potential effects of the DWH event presented here are based on past studies, current interviews with scientists participating in field studies, and observation teams concerning the types of possible effects the spill could have on these resources.

Chenier Plain

The Chenier Plain of eastern Texas and western Louisiana began developing about 3,000 years ago. During that period Mississippi River Delta sediments were intermittently eroded, reworked, and carried into the Chenier Plain area by storms and coastal currents. This deposition gathered huge volumes of mud and sand, and formed a shoreface that slopes very gently (almost imperceptibly) downward for a long distance offshore. This shallow mud bottom is viscous and elastic, which generates hydrodynamic friction (Bea et al., 1983). Hence, wave energies along the barrier shorelines of the Chenier Plain are greatly reduced and cause minimal longshore sediment transport along the Chenier Plain (USDOI, GS, 1988). More recently, this shoreline has been eroding as sea level rises, converting most of the coast to transgressive shorelines.

During periods when the course of the Mississippi River was at the western edge of its Deltaic Plain, sediments from the river were carried westward by currents along the shore. This formed mudflats along the Chenier Plain shoreline (Kemp, 1986). When the active river channel moved eastward and the Chenier Plain lost most of its sediment supply, erosion reworked the mud deposits. This winnowed out the finest materials and formed beachfront ridges (cheniers) along the coast, leaving remnants of the old mudflats (now marshes) behind them. The present topography reflects multiple river mouth ridges converging to form a single beachfront ridge between the river inlets (Gosselink et al., 1979). With the increase of flow this century in the Atchafalaya River close to the western edge of the delta, fluvial processes are again dominating the Chenier Plain, and mudflat development is occurring along its eastern coast (Kemp, 1986). Today, the Red River and about 30 percent of the Mississippi River are diverted to the Atchafalaya River. The diversions have increased the sediment load in the longshore currents that generally move slowly westward along the coast.

The barrier beaches of the Chenier Plain are generally narrow, low, and sediment starved due to the nature of coastal currents and the shoreface. Beach erosion has exposed relic marsh terraces that were buried by past overwash events. The Chenier Plain also supports an extensive marshland interspersed with large inland lakes formed in river valleys that were drowned after the last glaciation. When the sea reached its present level, the shoreline was more landward. Hurricane Rita (2005) severely impacted the shoreface and beach communities of Cameron Parish in southwest Louisiana. Some small towns in this area have no standing structures remaining. A storm surge approaching 6 m (20 ft) caused beach erosion and overwash, which flattened coastal dunes, depositing sand and debris well into the back marshes. After Rita, Hurricane Ike (2008) came ashore just west of the Texas/Louisiana border, severely impacting the eastern Chenier Plain near Cameron, Louisiana with a storm surge of 1-3 m (3-10 ft) that overtopped the beach and severely impacted the Chenier Plain.

Coastal change includes both beach erosion and erosion of channels where water continues to flow seaward to the Gulf of Mexico (Doran et al., 2009). In addition to the hurricane effects, the shoreline of the Chenier Plain was exposed to dispersed oil from the DWH event. Based on the SCAT observation maps available as of September 20, 2010, that portion of the Louisiana coastline from the area east of the Chenier Plain to the Louisiana/Mississippi State boundary was exposed to oil. The shoreline was untouched from this point to just east of Rockefeller Wildlife Refuge and Game Preserve (LA State Highway 3147). Observations by the SCAT field observers noted no oil in these areas. A year later (September 28, 2011) the shoreline was not identified by SCAT as showing oiling from the Chenier Plain to just east of Rockefeller Wildlife Refuge and Game Preserve (LA State Highway 3147) (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). Since there is no publicly available archival information on any changes to the Chenier Plain from oil exposure, it can only be reported that the areas were oiled but to varying degrees and for varying durations. The oiled sites are still under observation and the cleanup and monitoring operations are ongoing.

Mississippi River Delta Complex

The Mississippi Delta region comprises much of coastal Louisiana and adjacent Mississippi. It stretches from the Atchafalaya Bay to the Chandeleur Islands and includes the New Orleans metropolitan area. The Delta complex contains major river channels and levees, bayous, swamps, marshes, lakes, tidal flats and channels, barrier islands, and shallow sea environments. Most barrier shorelines of the Mississippi River Delta in Louisiana are transgressive and trace the seaward remains of a series of five abandoned deltas. As a lobe of the delta is abandoned by a shift in drainage, that portion begins to subside slowly into the sea and is further reduced by erosion. Some of the sediment may be reworked by wind and waves into barrier islands. The Chandeleur Islands and Grand Isle are an excellent example of this situation. Gradually, woodland vegetation became established on the dune sands (e.g., oaks and oleander). Salty meadows, marshes, and lagoons occupy the lower terrain. Today, the Mississippi River is channelized through the Belize Delta, more commonly known as the Birdsfoot Delta. Channelization isolated the river from most of this sixth (Birdsfoot) delta, except near the distributary mouths. There, a small fraction of the river's sediment load is contributed to longshore currents for building and maintaining barrier shores. The bulk of river sediments are deposited in deep water, where they cannot be reworked and contribute to the longshore sediment drift. The shorefaces of the Mississippi River Delta complex slope gently seaward, which reduces wave energies at the shorelines. Mud flats are exposed during very low tidal events. This slope is not as shallow as that found off the Chenier Plain. The steepest shoreface of the delta is found at the Caminada-Moreau Coast, where the greatest rates of erosion occur. At this site, the longshore currents split to the east and west, which removes sand from the area without replenishment (Wolfe et al., 1988; Wetherell, 1992; Holder and Lugo-Fernandez, 1993).

Regressive shorelines do occur in Louisiana's deltaic region. The diversion at the Atchafalaya River has allowed the transport of large volumes of sediment into the shallow Atchafalaya Bay. There, inland deltas are forming at the mouths of the Atchafalaya River and Wax Lake Outlet. Satellite photography of these deltas reveals that dredge-disposal islands were constructed off Point au Fer in shallow water (3-5 ft; 1-2 m) at the mouth of Atchafalaya Bay. If the Atchafalaya River Delta continues to build seaward as expected, these islands and the surrounding shallows would provide the foundations for a future barrier shoreline in this area.

Barrier island chains in the northern GOM extending from Atchafalaya Bay, Louisiana, to Mobile Bay, Alabama, are disintegrating rapidly as a result of combined physical processes involving sediment availability, sediment transport, and sea-level rise. The cumulative areas and rates of landloss from these ephemeral features are to some extent expected because present physical conditions are different from those that existed when the islands first formed. For example, during the past few thousand years sediment supply has diminished, rates of relative sea-level rise have increased, and hurricanes and winter storms have been frequent events that generate extremely energetic waves capable of permanently removing sediment from the islands. These processes continuously act in concert, increasing the rates of beach erosion and reducing the area of coastal land.

At greatest risk of further degradation are the barrier islands associated with the Mississippi Delta; these include the Chandeleur-Breton Island, Timbalier Island, and Isle Dernieres chains in Louisiana.

These chains of individual transgressive barrier island segments have progressively diminished in size while migrating landward (McBride et al., 1992). Most of southeastern Louisiana's barrier beaches are composed of medium to coarse sand. Small shoreline regressions occur as a result of jetties located on the eastern end of Grand Isle, the western end of Caminada-Moreau Beach, the Empire navigational canal, and elsewhere in Louisiana. Most dune zones of the Mississippi River Delta contain low, single-line dune ridges that may be sparsely to heavily vegetated. Generally in this area, the vegetation on a dune ridge gets denser as the time between storms lengthens. Unfortunately, the past decade had an increase in tropical storm activity for the project area.

Hurricane Katrina (2005) caused severe erosion and landloss for the coastal barrier islands of the Deltaic Plain. The eye of Hurricane Katrina passed directly over the 50-mi (80-km) Chandeleur Island chain. Aerial surveys conducted by USGS on September 1, 2005, show that these islands were heavily damaged by the storm (USDOI, GS, 2005). The Chandeleur Islands were reduced by Hurricane Katrina from 5.64 mi^2 to 2.5 mi^2 (14.61 km^2 to 6.5 km^2) and then to 2.0 mi^2 (5.2 km^2) by Hurricane Rita (Di Silvestro, 2006). Grand Isle received extremely high winds and a 12- to 20-ft (3.5- to 6-m) storm surge that caused tremendous structural damage to most of its camps, homes, and businesses (Louisiana Sea Grant, 2006). Although barrier islands and shorelines have some capacity to regenerate over time, the process is very slow and often incomplete. With each passing storm, the size and resiliency of these areas can be diminished, especially when major storms occur within a short time period. Hurricane Katrina was the fifth hurricane to impact the Chandeleur Island chain within an 8-year period. The other storms were Hurricanes Georges (1998), Lili (2002), Ivan (2004), and Dennis (2005). Landmass rebuilt since Hurricane Ivan was subsequently washed away by Hurricane Katrina. Hurricanes Gustav and Ike (2008) reactivated ponds caused by the surge of Katrina. Surge impacts of Hurricane Gustav in the Deltaic Plain are smaller in scale and magnitude than surge impacts of Hurricane Ike in the Chenier Plain. The effects of Hurricane Gustav were also seen in the further erosion of the Chandeleur Islands, as well as significant erosion of the barrier islands forming the southern boundary of Terrebonne and Timbalier Bays (Barras, 2009). The Chandeleur Islands were reduced to 544.5 ha (1,345.5 ac), a reduction of 102.6 ha (253.5 ac) from the island's land area of 647.1 ha (1,599.0 ac) in 2006 (Barras, 2009). Following Hurricane Ike, significant surge-formed and surge-expanded ponds were not really noticeable east of Vermilion Bay (Barras, 2009). Some new scours located on southeastern Marsh Island were originally scoured by Hurricane Lili on October 3, 2002 (Barras, 2007b). Water levels were visibly lower on the 2006 imagery of the Marsh Island area, causing the shallow scours to be classified as land in that dataset. Boyd and Penland (1988) estimated that storms raise mean water levels 1.73-2.03 m (5.68-6.66 ft) above mean sea level from 10 to 30 times per year. Under those conditions, barrier islands of the Mississippi River Delta complex experience severe overwash of up to 100 percent. Shell Key is a barrier feature that varies greatly from the others around the Delta. It is located south of Marsh Island, Louisiana, at the mouth of Atchafalaya Bay, and is composed almost entirely of oyster-shell fragments. It is found amid extensive shell reefs, which are part of the Shell Keys National Wildlife Refuge. This dynamic feature builds and wanes with passing storms. In 1992 and 1999, Hurricanes Andrew and Francis reduced the island to little more than a shoal. The shallow, submerged shell reefs around Shell Key also serve as barrier features. Located on the other side of the bay's mouth and to the southeast, the Point au Fer Shell Reefs were commercially dredged for shells, and no longer exist (USDOI, FWS and USDOC, Census Bureau, 2001; Schales and Soileau, official communication, 2001).

In addition to the hurricanes and winter storms, the Mississippi River Delta complex and its associated barrier islands were initially oiled as a result of the DWH event. Before the capping and permanent plugging of the well was complete, oil had reached the shorelines of the Chandeleur Islands, Whiskey Island, Raccoon Island, South Pass, East Fourchon/Elmers Island, Grand Isle, Trinity Island, and Brush Island (Cleveland, 2010). Most of Louisiana's shoreline had some exposure to oil. Some areas were oiled more than once. The oiling ranged from light to heavy to occasional tarballs depending on the location and time. In most cases, the oil came ashore in lines perpendicular to the shoreline rather than in sheets. In an attempt to protect the Chandeleur Islands and the marshes shoreward of the islands from oil, the State of Louisiana constructed protective berms seaward of the islands. (See **Chapter 3.3.3**, "OCS Sand Borrowing," regarding berms constructed in Louisiana as part of the DWH response). These berms are considered as part of the currently existing environment due to potential negative effects that this construction may have on the viability and sustainability of the protected island. Based on the review of currently available SCAT maps (USDOC, NOAA, 2011f [ERMA, September 28, 2011]) and field observations, the majority of the shoreline from the Atchafalaya Delta to the Mississippi River Delta is either categorized as not oiled or with small areas (2.8 km; 1.8 mi) that have a mixture of no oil and lightly oiled (USDOC, NOAA, 2011f [ERMA, September 28, 2011]).

Mississippi and Alabama Coasts

The only factor that has a historical trend that coincides with the progressive increase in rates of landloss is the progressive reduction in sand supply associated with nearly simultaneous deepening of channels dredged across the outer bars of the three tidal inlets maintained for deep-draft shipping. Neither rate of relative sea-level rise nor storm parameters have long-term historical trends that match the increased rates of landloss since the mid-1800's. The historical rates of relative sea-level rise in the northern Gulf of Mexico have been relatively constant, and storm frequencies and intensities occur in multidecadal cycles. However, the most recent landloss accelerations are likely related to the increased storm activity since 1995. The Mississippi-Alabama barrier islands do not migrate landward as they decrease in size. Instead, the centers of most of the islands are migrating westward in the direction of the predominant littoral drift through processes of updrift erosion and downdrift deposition (Richmond, 1962; Otvos, 1979). Although the sand spits and shoals of the Mississippi-Alabama barriers are being transferred westward, the vegetated interior cores of the islands remain fixed in space. Rucker and Snowden (1989) measured the orientations of relict forested beach ridges on the Mississippi barriers and concluded that the ridges and swales were formed by recurved spit deposition at the western ends of the islands. The Dog Keys define the Mississippi Sound of Mississippi and Alabama. Mississippi has about 33.9 mi (54.6 km) of barrier beaches on these islands (USDOI, FWS, 1999). Dauphin Island, Alabama, represents about another 7 mi (12 km). This relatively young group of islands was formed 3,000-4,000 years ago as a result of shoal-bar accretion (Otvos, 1979). They are separated by wide passes with deep channels. Shoals are typically adjacent to these barriers. Generally, these islands are regressive and stable in size as they migrate westward in response to the predominantly westward-moving longshore currents. These islands generally have high beach ridges and prominent sand dunes. The islands are well vegetated among and behind the dunes and around ponds. Southern maritime climax forests of pine and palmetto are found behind some of their dune fields.

Dauphin Island, Alabama, is the exception to the above description. It is essentially a low-profile, transgressive barrier island, except for a small, eroding, Pleistocene core at its eastern end. The western end is a Holocene spit that is characterized by small dunes and many washover fans, exposed marsh deposits, and tree stumps exposed in the surf zone. Dauphin Island experienced significant shoreline retreat and rollover after Hurricane Katrina, with overwash deposits forming in the sound. Pelican Island, Alabama, is a vegetated sand shoal located Gulfward of Dauphin Island. Southeasterly of that island is Sand Island, which is little more than a shoal. These barrier islands are part of Mobile Bay's ebb-tidal delta. As such, they continually change shape under storm and tidal pressures. Their sands generally move northwesterly into the longshore drift, nourishing beaches downdrift. These sediments can also move landward during flood tides (Hummell, 1990). The Gulf Shores region of Alabama extends from Mobile Point eastward to the Florida boundary, a distance of about 31 mi (50 km) (Smith, 1984). It has the widest beaches and largest dune system among the barrier beaches in the CPA.

Since the mid-1800's, average rates of landloss for all the Mississippi islands accelerated systematically. There is an inverse relationship between island size and percentage of land reduction for each barrier. For example, Horn Island, the largest of the Mississippi barrier islands, lost 24 percent and Ship Island lost 64 percent of its area since the mid-1800's (Morton, 2008). Ship Island is particularly vulnerable to storm-driven landlosses because topographic and bathymetric boundary conditions focus wave energy onto the island. The three predominant morphodynamic processes associated with landloss are as follows: (1) unequal lateral transfer of sand related to greater updrift erosion compared with downdrift deposition; (2) barrier narrowing resulting from simultaneous erosion of the Gulf and soundside shores; and (3) barrier segmentation related to storm breaching. The western portion of Dauphin Island is migrating landward as a result of storms that erode the Gulf shore, overwash the island, and deposit sand in Mississippi Sound. This has caused a gain in land during the 20th century. Petit Bois, Horn, and Ship Islands have migrated westward as a result of predominant westward sediment transport by alongshore currents, and Cat Island is being reshaped as it adjusts to post-formation changes in wave and current patterns associated with deposition of the St. Bernard lobe of the Mississippi Delta (Morton, 2008).

The principal causes of barrier island landloss are frequent intense storms, a relative rise in sea level, and a deficit in the sediment budget. However, the most recent landloss accelerations are likely related to the increased storm activity since 1995. Although overwash channels do not commonly occur, the islands may be overwashed during strong storms, as was seen after Hurricanes Ivan (2004), Dennis (2005), and Katrina (2005). Hurricane Katrina's storm surge caused substantial beach erosion and, in some cases, completely devastated coastal areas. In Dauphin Island, approximately 90 mi (150 km) to the east of the point where the hurricane made landfall, the sand that comprised the barrier island was transported across the island into Mississippi Sound, pushing the island towards land.

Deepwater Horizon Event Oil Exposure

In April 2010, the explosion of the DWH drilling platform resulted in the largest oil spill in the history of the U.S. The spill was approximated at 4.1 MMbbl of oil being released into the environment; the well was capped on July 15, 2010, after oil flowed into the Gulf for 87 days. The drilling rig was located west of the Mississippi River approximately 90 mi (145 km) from the Louisiana coast. The bulk of the oil was off the coast of Louisiana, but eventually the oil spread east of the Mississippi River along the Mississippi, Alabama, and Florida coastlines as far away as Panama City, Florida. At the time of preparation of this EIS, there remains incomplete and unavailable scientific information on the impacts of the spill. The available information presented here is primarily from accounts based on interviews with scientists or personnel with the USCG's Oil Spill Response Team at the Unified Command Post overseeing cleanup operations. Various wildlife and resource agencies have launched SCAT to locate the oil as it appears in order to engage cleanup teams. Other agencies are involved in the NRDA process, which is collecting data to identify and quantify the impacts of the spill. To date, only select portions of this information is publicly available; therefore, the information presented here only notes what resources have been contacted by the spilled oil based on the latest available SCAT observation maps and data available from interviews of local scientists participating in the oil response effort (USDOC, NOAA, 2011f [ERMA, September 28, 2011]).

Initially, the DWH event exposed most of the Gulf Coast shoreline to some degree of oiling (i.e., from western Louisiana to the Florida panhandle) (OSAT-2, 2011). This cumulative figure of oiled shoreline includes the shorelines of beaches and barrier islands that were exposed to oil whether it was very light, light, moderate, heavily oiled, or only observations of tarballs. In Louisiana, the heavy to moderate oiling was sporadic along the shorelines of Grand Terre Island, Grand Isle, and Bay Batiste. By May 23, 2010, the Louisiana Department of Environmental Quality had confirmed shoreline impact on the Chandeleur Islands, Whiskey Island, Raccoon Island, South Pass, East Fourchon/Elmers Island, Grand Isle, Trinity Island, Brush Island, the Pass a Loutre area, and Marsh Island. On June 1, 2010, oil first appeared on Dauphin Island off the coast of Alabama near the mouth of Mobile Bay. Strands of oil about 1 m (3 ft) wide and 2 mi (3 km) long were found on Petit Bois Island near the Mississippi-Alabama border (Cleveland, 2010). The shoreline in the Barataria Bay complex, along with the shorelines west of the Mississippi River Delta complex, received the most oil (Cleveland, 2010). Some of these areas may have been oiled several times.

By comparison, more recent available SCAT observations (USDOC, NOAA, 2011f [ERMA, September 28, 2011]) note barrier islands from the Texas border to the Alabama/Florida border with much less remnant oil than was reported a year ago (September 2010). Based on an additional review of SCAT observation maps (USDOC, NOAA, 2011f [ERMA, September 28, 2011]), the remnant oil along these shorelines continues to be greatly reduced and is expected to be further removed through cleanup efforts, weathering, and the high-energy wave action in these areas. All of the following estimates of oiled shorelines were created from the measurement tool associated with the SCAT maps (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). Based on these SCAT observations (September 28, 2011), the Louisiana coast from the Texas State line (Sabine) to the Mississippi State line continues to improve.

Observations on the Chandeleur Islands indicated no oil on the seaward side of the islands, a small area of moderate to heavy remnant oil on the back side of the islands, and a small heavily oiled area in the interior of the island (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). Grand Isle still has moderate oiling on the eastern tip of the island (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). Grand Terre Island has either traces of oil or is lightly oiled on its Gulf side, with the exception of a small area (approximately 33 m [108 ft]) that is still heavily oiled on the eastern end of the Island (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). The Gulf Island National Seashore chain (i.e., Cat, Horn, Petit Bois Islands, etc.) off the Mississippi coast is primarily free of remnant oil except for a small segment that is lightly oiled (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). While all of these coastlines previously received various degrees of oiling, the remnant oil that is currently observed is weathered oil that has been treated and has either no or much reduced toxic components. Because these coastlines encountered some degree of oiling, oil may now be part of the existing condition of the resource. As noted in the more recent SCAT observations, this oil is expected to continue to be removed from the shoreline by cleanup efforts, weathering, and the high-energy wave action in these coastal environments that continuously reworks the shoreline. The SCAT maps and new data available since the DWH event that are incorporated into this EIS provide valuable information on the status of coastal barrier beaches and dunes that may have been impacted by the event.

As identified in this chapter, BOEM acknowledges that there remains incomplete and unavailable information related to coastal barrier beaches and associated dunes that may be relevant to reasonably foreseeable significant impacts on these resources. For example, although there is substantial information available since the DWH event, which is included in this EIS, additional information will likely be developed through the NRDA process. The BOEM believes that the incomplete or unavailable information regarding coastal barrier beaches and dunes would likely not be essential to a reasoned choice among alternatives, particularly in the cumulative effects analysis. The bulk of this information is expected to be developed through the ongoing NRDA process. To date, relatively little raw data have been released publicly by the NRDA process, and it may be years before studies are completed and results are released. This information will certainly not be available within the timeframe contemplated by this NEPA analysis. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. The BOEM subject-matter experts have used what scientifically credible information is available in their analyses, including the recent SCAT data, and applied this information using accepted scientific methodology.

4.2.1.3.2. Impacts of Routine Events

Background/Introduction

Impacts to the general vegetation and physical aspects of coastal environments by routine activities resulting from a CPA proposed action are considered in detail in **Chapter 4.2.1.4.2**. This section considers impacts from routine activities associated with a CPA proposed action to the physical shape and structure of barrier beaches and associated dunes. The primary impact-producing routine activities associated with a CPA proposed action that could affect these environments include pipeline emplacements, navigation channel use (vessel traffic) and dredging, and the use and construction of support infrastructure.

Pipeline Emplacements

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Many OCS Program-related pipelines make landfall on Louisiana's barrier islands and shorelines. Pipeline landfall sites on barrier islands could cause accelerated beach erosion and island breaching. A CPA proposed action does not include new pipelines that make landfall on barrier islands or mainland beaches. If more detailed site-specific, postlease analysis indicates barrier beach landfalls are necessary, modern techniques such as directional drilling would be used to bring the pipeline ashore. Studies have shown that little to no impact to barrier beaches results from modern techniques such as directional boring (LeBlanc, 1985; Wicker et al., 1989). Since 2002, only one new pipeline has come to shore in Louisiana from OCS-related activities. The 30-in Endymion oil pipeline, which delivers crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field, was installed in 2003. Based on a review of the data in the COE permit application (No. 20-020-1632), the emplacement of the pipeline caused zero impacts to marshes (emergent wetlands) and beaches. This was because the operator used horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the pipeline route maximized an open-water route to the extent possible. A comparison of aerial photos taken before and after Hurricanes Katrina and Rita reveal no observable landloss or impacts associated with the Endymion oil pipeline. Hurricane Gustav further eroded barrier beaches and completely degraded small islands such as Wine Island. Although Hurricane Gustav eroded some beaches and damaged onshore pipelines near Port Fourchon, offshore pipelines were left intact.

Vessel Traffic and Dredging

Vessel traffic that may support a CPA proposed action is discussed in **Chapter 3.1.1.8.4.** Navigation channels projected to be used in support of a CPA proposed action are discussed in **Chapter 3.1.2.1.8.** Navigation channels that support the OCS Program are listed in **Table 3-14**. Current navigation channels would not change, and no new navigation channels are required as a result of a CPA proposed action.

Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion processes. Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Louisiana coast. There is a small potential for resuspension and transport of oil from the DWH event as a result of heavy vessel traffic or dredging in areas previously oiled and where submerged oil mats exist. As a result of the storm surge of Hurricane Gustav, the channel at Port Fourchon lost depth from siltation and displacement of some of the rock channel armor.

Based on an earlier study by Johnson and Gosselink (1982), canal widening rates in coastal Louisiana range from about 2.58 m/yr (8.46 ft/yr) for canals with the greatest boat activity to 0.95 m/yr (3.12 ft/yr) for canals with minimal boat activity. A recent study entitled "Navigation Canal Bank Erosion in the Western and Central Gulf of Mexico" indicates that shoreline retreat rates along canals were highly variable within and across unarmored portions of the canals (Thatcher et al., 2011). It was noted that geology and vegetation type influenced the rate of shoreline change. The study also noted that the canal widening rate slowed to -0.99 m/yr (-3.25 ft/yr) for the 1996/1998-2005/2006 time period as compared with -1.71 m/yr (-5.61 ft/yr) for the 1978/1979-1996/1998 time period. The existing armored navigation channels (e.g., Port Fourchon) that are used to reach shore bases minimize or eliminate the potential for shoreline erosion from vessel traffic. Widening rates for navigation canals have been reduced as a result of aggressive management and the restoration of canal edges to prevent erosion. An example of this is the construction of rock breakwaters along portions of some of these canals, as well as enforcing "wake zone" speeds (Johnston et al., 2009). In addition, BOEM and the USGS National Wetlands Resource Center have designed and funded a study that was reviewed and coordinated with the Louisiana Department of Natural Resources to better understand salinity behavior in marshes adjacent to navigation canals. This 2-year study began in January 2010 and is scheduled for completion in 2012.

Remnant oil is still being found intermittently in coastal areas. This remnant oil has been treated with dispersants and weathered, but it has the potential for resuspension as a result of the routine activities noted above. If encountered, the remnant oil is expected to be nontoxic due to natural weathering, microbial breakdown, and post-spill dispersant treatments. The last overflight observation of potentially recoverable oil on the ocean surface was made on August 3, 2010 (OSAT, 2010). With regard to samples taken, "Since 3 August 2010, <1% of water samples and ~1% of sediment samples exceeded USEPA's Aquatic Life benchmarks for PAH's. Analysis of individual samples indicated that none of the water sample exceedances were consistent with MC252. Of the sediment exceedances, only those within 3 km of the wellhead were consistent with MC252."

Subsurface tar mats were found in some nearshore sampling areas and could temporarily be remobilized and could become a source of shoreline reoiling (OSAT-2, 2011). If the remnant oil is encountered, routine activities such as dredging or vessel traffic can potentially resuspend and transport it within the area. The oil is greatly weathered and treated, so it is expected to have low or no level of toxicity for interstitial beach inhabitants and disturbance from routine activities is unlikely to significantly impact coastal barrier beaches and associated dunes. Based on the findings of the OSAT-2 report (2011), weathered oil samples showed PAH's were depleted by 86-98 percent in most beach locations. The PAH model predictions also predict that PAH concentrations in subtidal buried oil will decrease to 20 percent of current levels within 5 years (OSAT-2, 2011).

Continued Use of Support Infrastructure

In the past, OCS-related facilities were built in the vicinity of barrier shorelines of the CPA. The use of some existing facilities in support of a CPA proposed action and subsequent proposed lease sales in the CPA may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. For example, when structures are used to retain sand in a specific area, erosion (or reduced accretion) of the downdrift beaches will be caused by the reduced sediment supply coming from the protected area (American Shore and Beach Preservation Association, 2011). They may also cause the accumulation of sediments updrift of the structures. These sediments might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In deltaic Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts would last as long as the interruption of the sediment drift continues and can continue after the structure is removed if the hydrodynamics of the area are permanently modified. Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat. Abandoned facility sites must be cleared in accordance with Federal, State, and local government, and landowner requirements. Materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

Zero to one pipeline landfalls are projected as a result of a CPA proposed action. Should one be constructed, it would most likely be in Louisiana, where the large majority of the infrastructure exists for receiving oil and gas from the CPA. No landfalls are presently planned for barrier or mainland beaches, but if it is later determined that such a landfall in the vicinity of a barrier beach and associated dunes is necessary, current regulatory procedures would be used to evaluate any impacts associated with the action. Wherever a landfall occurs, regulatory programs and permitting processes (COE and the Louisiana Dept. of Natural Resources) are sequenced to ensure wetlands are protected first through avoidance, then minimization of impacts, and finally compensation for unavoidable impacts. The use of modern technologies (e.g., directional boring) greatly reduces and possibly eliminates impacts to coastal barrier islands and beaches. Therefore, effects on barrier beaches and dunes from pipeline laying activities associated with a CPA proposed action are expected to be minor or nonexistent.

A CPA proposed action is estimated to account for 2-3 percent of the service-vessel traffic in navigation canals associated with the OCS Program from 2012 through 2051 (**Tables 3-3 and 3-4**). Erosion of coastal barrier beaches and associated dunes from vessel traffic associated with a CPA proposed action are expected to be negligible.

Adverse impacts from maintenance dredging of navigation channels can be mitigated by discharging dredged materials onto barrier beaches or strategically into longshore sediment currents downdrift of maintained channels, or by using the dredged material to create wetlands. Negative effects of sediment sinks created by jetties can be mitigated by reducing the jetty length to the minimum needed and by filling the downdrift side of the jetty with appropriate sediment. Sediment traps that are created by unnecessarily large bar channels can also be mitigated by reassessing the navigational needs of the port and by appropriately reducing the depth of the channel. These dredging activities are permitted, regulated, and coordinated by COE with the appropriate State and Federal resource agencies. Impacts from these operations are minimal due to requirements for the beneficial use of the dredged material for wetland and beach construction and restoration where appropriate. Permit requirements further mitigate dredged material placement in approved disposal areas by requiring the dredged material to be placed in such a manner that it neither disrupts hydrology nor changes elevation in the surrounding marsh. Effects on coastal barrier beaches and associated dunes associated with dredging from a CPA proposed action are expected to be restricted to minor and localized areas downdrift of the channel. There are 0-1 gas processing plants projected to be constructed as a result of a CPA proposed action. Should one be constructed, it would most likely be in Louisiana. Effects on coastal barrier beaches and associated dunes associated with the construction of a gas processing plant from a CPA proposed action are expected to be restricted to minor and very localized areas downdrift of the channel.

The SCAT maps and data available since the DWH event that are incorporated into this EIS provide valuable information on the status of coastal barrier beaches and dunes that may have been impacted by the event. There remains incomplete and unavailable information that may be relevant to reasonably foreseeable significant impacts on these resources. Nevertheless, there is substantial information available since the DWH event which is included in this EIS, and BOEM believes that the incomplete or unavailable information regarding effects of the DWH event on coastal barrier beaches and dunes would likely not be essential to a reasoned choice among alternatives. The bulk of this information is expected to be developed through the ongoing NRDA process. To date, relatively little raw data have been released publicly by the NRDA process, and it may be years before studies are completed and results are released. This information will certainly not be available within the timeframe contemplated by this NEPA analysis. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. The BOEM subject-matter experts have used what scientifically credible information is available in their analyses, applied using accepted scientific methodology. As noted above, even if there remain unknown impacts to coastal barrier beaches and dunes from the DWH event, impacts from routine activities related to a CPA proposed action would not be expected to be substantial since most routine activities are located far from coastal beaches or would be subject to permitting and location siting requirements (e.g., dredging and pipeline landfalls).

Summary and Conclusion

Effects to coastal barrier beaches and associated dunes from pipeline emplacements, navigation channel use and dredging, and construction or continued use of infrastructure in support of a CPA proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 pipeline landfalls projected in support of a CPA proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods and regulations. Any new processing plants would not be expected to be constructed on barrier beaches.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which, combined with channel jetties, causes minor and localized impacts on adjacent barrier beaches. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies. Because these impacts occur regardless of a CPA proposed action, a proposed action would account for a small percentage of these impacts from routine events. There could be a slight chance of disturbing or resuspending buried, remnant oil from the DWH event through channel maintenance or trenching associated with pipeline placement. However, based on sediment analyses in the OSAT report (2010), there were no exceedances of USEPA's aquatic life benchmarks for PAH's in sediment beyond 3 km (~2 mi) from the wellhead that were linked to the oil from the DWH event. Since dredging, vessel traffic, and pipeline emplacement activities would be far removed from most affected areas, the chance of resuspension of toxic sediment would be improbable.

In conclusion, a CPA proposed action is not expected to adversely alter barrier beach configurations much beyond existing, ongoing impacts in localized areas or to result in remobilizing toxic remnant oil. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

4.2.1.3.3. Impacts of Accidental Events

Background/Introduction

Impacts to the general vegetation and physical aspects of coastal environments by oil spills and cleanup response activities resulting from a CPA proposed action are considered in **Chapters 4.2.1.3.3 and 4.2.1.4.3**. The types and sources of spills that may occur and their characteristics are described in **Chapter 3.2.1**. There is also a risk analysis of accidental events in **Chapter 3.2.1**. **Figures 3-9 and 3-10** provide the probability of an offshore spill ≥1,000 bbl occurring and contacting counties and parishes around the Gulf. A low-probability catastrophic spill is discussed in **Appendix B**.

Potential impacts from oil spills to barrier islands seaward of the barrier-dune system are considered in this section, while potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis (**Chapter 4.2.1.4.3**). Impacts to biological, recreational, and archaeological resources associated with beach and dune environments are described in the impact analysis sections for those specific resources.

Oil-Spill Impacts

While it is possible that unweathered oil may reach shorelines, it not probable from a CPA proposed action. Moreover, for tides to carry oil from a spill across and over the dunes, strong southerly winds would have to persist for an extended time prior to or immediately after a spill. Strong winds required to produce such high tides would also accelerate dispersal and spreading of the oil slick, thereby reducing impact severity at the landfall site. Significant dune contact by a spill associated with a CPA proposed action is not likely; however, the reduced degree of protection does make the mainland beaches and habitat on the back side of the barrier islands more susceptible to oiling than they were under pre-storm conditions if winds bring the oil shoreward. If the unweathered oil and its toxic components reached the fine and soft sediment beaches, the interstitial microfauna associated with the beach face may be affected. The effects could be changes in species diversity that could result in changes in forage areas for species using these microfauna as a food base (Teal and Howarth, 1984).

There are various factors and conditions that affect the toxicity and severity of oil spills on the barrier island systems and the associated vegetation. The two most important variables involve location (distance of spill from landfall) and weather. If there is sufficient distance and contributing weather conditions between the spill and landfall, the spill can be dispersed, thinned, and emulsified. This would allow for optimal conditions for biodegradation, volatilization, and photooxidation. Therefore, due to the distance from shore of the spill, the weather, the time oil remains offshore, and dispersant use (see discussion of dispersants in **Chapter 3.2.1.5.2**), offshore-based light Louisiana crude oil would be less toxic when it reaches the coastal environments. In addition, the GOM has more natural oil seeps (provide 400,000 bbl/year) than any other marine environment in North America; therefore, the GOM has a resident population of microbiota, including oil-biodegrading bacteria that are adapted to this environment and that rapidly respond to degrade any additional oil that enters the environment (Atlas and Hazen, 2011). The resiliency of coastal beaches and the effect of oil on these beaches are, in part, based on the toxicity of the oil's components once it reaches the beaches. Recent insight into the fate of oil that may reach beaches from an offshore spill has been noted in the OSAT-2 report (2011). Based on the OSAT report (2010), even the oil that reached the shore from the catastrophic DWH event was weathered to the point that no USEPA exceedances were observed for aquatic life or wildlife in the sediments or water samples from 3 km (~2 mi) from the well head shoreward. Beach samples indicated 86-98 percent depletion of total PAH, and in most locations, it was estimated that buried supratidal oil (most resilient due to no oxidation) would decrease to 20 percent of current levels within 5 years (OSAT-2, 2011).

Inland spills have the greatest potential for affecting the coastal barrier resources due to their proximity to the resources. Inland spills resulting from damage to pipelines, vessel collisions, malfunctions of onshore production or storage facilities, and blowouts have the greatest potential for contacting the barrier and mainland beach resources. The effects from these oil spills depend on the geographic location, volume, and rate of the spill; type of oil; oil-slick characteristics; oceanic conditions and season at the time of the spill; and response and cleanup efforts. Inland spills from offshore coastal waters and in the vicinity of Gulf tidal inlets present a greater potential risk to barrier beaches and dunes because of their close proximity, but inland spills occurring away from Gulf tidal inlets are not expected to significantly impact barrier beaches and dunes.

No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of accidental events associated with a CPA proposed action. However, as a result of the DWH event, the State of Louisiana has partially constructed an oil mitigation berm seaward of the Chandeleur Islands (**Chapter 3.3.3**). Theoretically, the berm is to protect the island and inland marshes from incoming oil. The Federal resource agencies (i.e., NMFS, FWS, and USEPA), as well as the local scientific community, are concerned that the berm may cause further erosion of the island because of changes to hydrology and topography (Lavioe et al., 2010). In addition, the use of heavy equipment for shaping the berm material and the chance of disturbing pipelines in the borrow areas could cause potential indirect impacts to the coast.

The results of an earlier study (Webb, 1988) utilizing oiled and unoiled sands indicated the survival of dune transplants was better for both species of plants tested in the oil-contaminated dune than the oil-free dune. It was concluded that common dune plants can colonize or can be transplanted successfully into oil-contaminated sands. The explanation of the favorable survival is probably due to the weathering from the photooxidation, volatilization, and biodegradation of the oil. Analysis of the weathered crude oil did not indicate a high percentage of PAH's. The study concluded that the weathering process removed most of the toxic compounds (Webb, 1988).

Through cleanup efforts, associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. Certain mainland beaches in Louisiana (Grand Isle and Grand Terre Island), Mississippi (Waveland, Biloxi, and Gulfport), Alabama (Perdido and Gulf Shores), and Florida (Santa Rosa, Pensacola, and Eglin) are currently undergoing either manual or mechanical cleanup primarily for tarballs or some submerged weathered oil mats. Mechanical, tractor-mounted sifters disrupt the sand base, cause compaction, and disturb the nontidal beach habitat. Should a spill contact a barrier beach, oiling is expected to be light due to the distance of most OCS Program activities from barrier beaches and sand removal during cleanup activities minimized because current spill-response activities discourage physical cleanup methods in beaches and marshes. Residual oils from the DWH event are still being cleaned in various locations. Based on the September 2011 and more recent SCAT information, remnant oil on barrier and mainland beaches ranges from no oil/lightly oiled to only a few moderately oiled sites noted in sections above. The OSAT-2 report (2011) further noted that there was a greater potential for impact to wildlife and aquatic resources from aggressive cleanup than from the remnant oil on the beaches . The Net Environmental Benefits Analysis done as part of the OSAT-2 report (2011) noted that the environmental effects of residual oil remaining after cleanup are relatively minor when compared with the effects of continued cleanup efforts on both the beach habitats and associated resources. This is because, as both mechanical and manual methods are used to remove smaller amounts of oil, they are physically altering the state of the environment.

The SCAT maps and new data available since the DWH event that are incorporated into this EIS provide valuable information on the status of coastal barrier beaches and dunes that may have been impacted by the event. The BOEM acknowledges that there remains incomplete and unavailable information that may be relevant to reasonably foreseeable significant impacts on these resources. As there is substantial information available since the DWH event, which is included in this EIS, BOEM believes that the incomplete or unavailable information regarding effects of DWH on coastal barrier beaches and dunes would likely not be essential to a reasoned choice among alternatives. The bulk of this information is expected to be developed through the ongoing NRDA process. To date, relatively little raw data have been released publicly by the NRDA process, and it may be years before studies are completed and results are released. This information will certainly not be available within the timeframe contemplated by this NEPA analysis. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. The BOEM subject-matter experts have used what scientifically credible information is available in their analyses, applied using accepted scientific methodology. The likelihood of any accidental event reaching coastal barrier beaches remains remote due to the fact that most routine activities are far removed from coastal barrier beaches and dunes. Most activities that could result in inshore spills (e.g., vessel traffic) would also likely be in navigational channels at some distance from most barrier beaches and dunes.

Proposed Action Analysis

Barrier islands and beaches adjacent to the CPA are restricted to the coastal waters of Louisiana, Mississippi, Alabama, and western Florida. The greatest threat to the barrier island and beach resources would be from inland oil spills. Based on the assumption that spill occurrence is proportional to the volume of oil handled, sensitive coastal environments in eastern Louisiana from Atchafalaya Bay to east of the Mississippi River (including Barataria Bay) have the greatest risk of contact from spills related to a CPA proposed action.

The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past, as long as the level of energy-related, commercial and recreational activities remain the same. Therefore, the coastal waters of Louisiana, Mississippi, and Alabama would have a total of 200, 30, and 10 spills <1,000 bbl/yr, respectively, from all sources, as a result of a CPA proposed action. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Mississippi, and Alabama would have a total of 130-170, 3-5, and ~2 spills <1,000 bbl/yr, respectively. Louisiana is the state most likely to have a spill occurrence of ≥1,000 bbl in its coastal waters as a result of a CPA proposed action.

Activity that would result from the addition of a CPA proposed lease sale would cause a negligible increase in the risk of a large spill occurring and contacting barrier islands and beaches. If oil should reach the beaches from this distance, it would be sufficiently weathered and detoxified through biodegradation, mixing, and the weathering process. The probabilities of an offshore spill ≥1,000 bbl occurring and contacting environmental features are described in **Chapters 3.2.1.5.7**. In addition, the results of a risk analysis estimating the likelihood of a <1,000-bbl spill occurring and contacting environmental resources (including barrier islands) can be found in **Chapters 3.2.1.6.6 and 3.2.1.7.2**. Eight parishes in Louisiana have a chance of a spill ≥1,000 bbl occurring and contacting their shores (**Figure 3-10**). For these parishes, the probability of an OCS offshore spill ≥1,000 bbl ranges from <0.5 to 8 percent. Generally, the coastal deltaic parishes of Louisiana have the highest risk of being contacted by an offshore spill resulting from a CPA proposed action. Plaquemines Parish has the highest probability at 3-8 percent (**Figure 3-10**). For offshore spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. A few (5-11) offshore spills of 50-1,000 bbl are estimated to occur as a result of a CPA proposed action, and a few of these slicks are expected to occur proximate to State waters and to reach shore (**Table 3-12**). Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Sensitive coastal environments in eastern Louisiana from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a CPA proposed action.

The potential impacts of a catastrophic spill such as the DWH event are discussed in **Appendix B** to the extent possible with the current data available. However, the probability of a catastrophic spill such as the DWH event is low. If a catastrophic spill such as the DWH event should occur, the extent of the oiling may vary depending on sea conditions, dispersant use, and response time and methods. As seen with the DWH event, physical alterations to hydrological conditions through berm construction may result in changes to future barrier island behavior. The end result of island modification as a result of changed hydrologic conditions due to berm construction will only be known through the results of long-term monitoring.

Summary and Conclusion

Due to the proximity of inshore spills to barrier islands and beaches, inshore spills pose the greatest threat because of their concentration and lack of weathering by the time they hit the shore and because dispersants are not utilized in inshore waters due to the negative effects on the shallow-water coastal habitats. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. Impacts of a nearshore spill would be considered short term in duration and minor in scope because the size of such a spill is projected to be small (coastal spills are assumed to be 77 bbl; **Chapter 3.2.1.7.1**). Offshore-based crude oil would be lessened in toxicity when it reaches the coastal environments. This is due to the distance from shore, the weather, the time oil remains offshore, and the dispersant used. Equipment and personnel used in cleanup efforts can generate the greatest direct impacts to the area, such as the disturbance of sands through foot traffic and mechanized cleanup equipment (e.g., sifters), dispersal of oil deeper into sands and sediments, and foot traffic in marshes impacting the distribution of oils and marsh vegetation. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Although monitoring is still ongoing, the current data show that the toxic components of remnant oil are expected to continue to decline as noted above (OSAT-2, 2011). Therefore, the currently available information suggests that impacts on barrier islands and beaches from accidental impacts associated with a CPA proposed action would be minimal. However, the long-term effects of the berm construction on Chandeleur Island cannot be evaluated at this time due to the lack of long-term monitoring data concerning the change in hydrological conditions created by the construction. Should a spill other than a catastrophic spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant long-term impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a CPA proposed action. A CPA proposed action would not pose a significant increase in risk to barrier island or beach resources.

4.2.1.3.4. Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a CPA proposed action, prior and future OCS sales in the Gulf of Mexico, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes that may affect barrier beaches and dunes. Specific impact-producing factors considered in this cumulative analysis include channelization of the Mississippi River, beach protection and stabilization projects, natural processes, navigation channels, development and urbanization, oil spills, oil-spill response and cleanup activities, pipeline landfalls, potential for nearshore salinity modifications (preparation of salt domes for oil storage), tourism, and recreational activities.

River Channelization and Beach Protection

Channel deepening and widening along the Mississippi River and other major coastal rivers, in combination with channel training and bank stabilization work, has resulted in the reduced delivery of sediment to the eroding deltas along the mouths of the rivers. This reduction in sediment not only impedes delta building, but it also fails to provide the needed sediment transport required for nourishment of the eroding offshore barrier islands and their beaches. This, coupled with beach building and stabilization projects utilizing mined sands, jetties, groins, and other means of sediment capture, is depriving natural restoration of the barrier beaches normally accomplished through sediment nourishment and sediment transport.

Subsidence, erosion, and dredging of inland coastal areas, with the concurrent expansion of tidal influences, continually increase tidal prisms around the Gulf. These changes may result in the opening and deepening of many new tidal channels that connect to the Gulf and inland waterbodies. These incremental changes would cause adverse impacts to barrier beaches and dunes. Efforts to stabilize the Gulf shoreline have adversely impacted barrier landscapes in Louisiana. Large numbers and varieties of stabilization techniques including groins, jetties, seawalls, and artificially maintained channels and jetties that were installed to stabilize navigation channels have been applied along the Gulf Coast. These efforts have contributed to coastal erosion by depriving downdrift beaches of sediments and by increasing or redirecting the erosional energy of waves (Morton, 1982). Over the last 20 years, better dune and beach stabilization has been accomplished by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings.

As a result of the DWH event, protective berms were constructed seaward of barrier islands (Chandeleur Islands), as well as west of the Mississippi River, to protect the inland marshes, wetlands, and seagrasses from incoming oil associated with this large spill. The effects of this berm construction on barrier islands could alter present sediment transport needed for barrier island growth, as well as change inlet velocities and hydrology in such a way that accelerated erosion of Chandeleur Island could occur (Lavoie et al., 2010). Aside from the construction impacts, the amount of mined sand required would continue to reduce the already scarce supply of sand needed for both natural barrier island building and future coastal restoration projects. Lavoie et al. (2010) suggested that long-term monitoring of the berms and the associated habitats would be needed to determine both possible future impacts and benefits to the surrounding environment and if the berm is performing as proposed. Long-term monitoring should include a combination of repetitive surveys of bathymetry, topography, and seabed imagery, along with sediment sampling to determine changes through time that are needed for documenting the movement and degradation of oil. In addition, the study suggested that salinity and turbidity be monitored in the back barrier to provide general information on estuary health and the suitability for the continued existence of aquatic grass beds (Lavoie et al., 2010). Other impacts include the fate of oil that may be sequestered in the mined sands, and the effects of their long-term release. The current testing of dredged sediments required under the COE dredging permit for the berm construction does not indicate the presence of petroleum-based toxicants at this time. The potential exists for anoxic conditions in deep holes where the sand is mined, but COE permit requirements establish that the underwater borrow sites should be backfilled or shallowed to the greatest extent possible.

Natural Processes

Barrier beaches along coastal Louisiana have experienced severe erosion and landward retreat (marine transgression) because of natural processes enhanced by human activities. Adverse effects on barrier beaches and dunes have resulted from changes to the natural dynamics of water and sediment flow along the coast. This can happen due to anthropogenic attempts to control catastrophic floods and change the natural environment to better accommodate navigation on waterways used to support OCS Program and non-OCS Program-related vessel traffic. Sea-level rise and coastal subsidence with tropical and extra-tropical storms exacerbate and accelerate the erosion of coastal barrier beaches along the Gulf Coast of Louisiana. The western edge of the CPA coast received major damage as a result of Hurricanes Katrina, Rita, and Gustav.

The central Gulf Coast (i.e., Louisiana, Mississippi, Alabama, and western Florida) and the associated barrier islands and beaches have experienced an increase in frequency of high-intensity hurricanes and tropical storms over the past several years. As a result of past powerful hurricanes (i.e., Hurricanes Katrina, Rita, and Gustav), changes in barrier island topography and decreases in beach elevation potentially increased the probability for oiling farther up the beach head in some locations. Due to the more gentle slopes, removal of beach ridges, and cuts into the mainland barrier beaches, the remnant transition zone between the water and the current beach ridge may be more vulnerable to spills. In some areas along the Louisiana coast, barrier islands were severely damaged, resulting in either heavily degraded beachfront elevations and ridges or submergence of the island from sediments being redistributed by the storm surge. In coastal Louisiana, dune-line heights have been drastically reduced by the storm activity. The Isle Dernieres and Chandeleur Island chains had losses in elevation and beach erosion. In Mississippi and Alabama, dune elevations exceed those in Louisiana but have been reduced to some extent due to storm activity. Hurricane Katrina completely inundated the western side of Dauphin Island, Alabama, decreasing elevations to less than 2 m (7 ft). Hurricane Gustav then completely overwashed the western edge of the island, resulting in large changes to the island's shape and topography (USDOI, GS, 2008). For tides to carry oil from a spill across and over the dunes, strong southerly winds would have to persist for an extended time prior to or immediately after a spill. Strong winds required to produce such high tides would also accelerate dispersal and spreading of the oil slick, thereby reducing impact severity at the landfall site. Significant dune contact by a spill associated with a CPA proposed action is not likely; however, the reduced degree of protection does make the mainland beaches and habitat on the back side of the barrier islands more susceptible to oiling than they were under pre-storm conditions if winds bring the oil shoreward.

The passage of these four powerful hurricanes within a 4-year period resulted in changes in barrier island topography and lowered beach elevation. These changes could potentially increase the probability for beach oiling farther up the beach in some locations. Due to the now more gentle slopes and in some cases cuts into the mainland barrier beaches left by the storms, more of the transition zone between the water and beach ridge may be more vulnerable to spills. In some areas along the Louisiana coast, barrier islands were severely damaged either by heavily degrading beachfront elevations and beach ridges or by completely overtopping the islands. This surge over the island resulted in either removing or completely redistributing the sediments on the island, so the island becomes submerged. Along the Mississippi/Alabama coast, barrier islands (e.g., Gulf Islands National Seashore chain and Dauphin Island) were further eroded and inlets widened by the series of storms following Hurricanes Katrina and Rita. The widening of inlets initiated by Katrina and Rita provided larger pathways for saltwater and oil influx into the island wetlands. Grand Isle, Louisiana, and its beach restoration project were severely damaged by Hurricanes Katrina and Gustav. These islands received oil on the beaches from the DWH event.

Hurricane Rita in September 2005 severely impacted the shoreface and beach communities of Cameron Parish in southwest Louisiana. These barriers lost elevation and vegetative cover as a result of the erosion forces accompanying the storm surge and scour from storm-driven debris (Barras, 2007b). The removal of vegetative cover and scour scars provides an avenue for additional erosion to occur as a result of inlet formations and tidal rivulets. If the topography is modified, it may result in hydrological changes that enable further sediment transport from the islands. This provides pathways for further erosion and saltwater intrusion into the less salt-tolerant interior vegetated habitats of the islands. The loss of elevation, combined with the shoreline retreat and removal of vegetation further aggravated by the hurricanes, allows for the expansion of the overwash zone. This lessens the pre-storm protection provided by these barrier islands. The reduction in island elevation results in less frontline protection to valuable marshes and makes urban and industrial areas protected by these marshes at a higher risk (USDOC, NMFS, 2007a).

Hurricanes and tropical storms will remain a part of the Gulf Coast weather pattern and will continue to affect the elevations of barrier islands, mainland beaches, and dunes. Depending on storm frequency and intensity, it may be possible for coastal restoration and protection projects to mitigate some of the physical damage to these areas.

Navigation Channels, Vessel Traffic, and Pipeline Emplacements

The effects to coastal barrier beaches and associated dunes from pipeline emplacements, navigation channel use and dredging, and the construction or continued use of infrastructure in support of a CPA proposed action are expected to be restricted to temporary and localized disturbances. The estimated 0-1 pipeline landfalls projected in support of a CPA proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods, and no pipeline routes are planned that would involve emplacement on barrier islands (**Chapter 3.1.2.1.6**). The estimated 0-1 gas processing plant would not be expected to be constructed on barrier beaches (**Chapter 3.1.2.1.4.2**). Existing inland facilities may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A CPA proposed action may contribute to the continued use of such facilities. Maintenance dredging of barrier inlets and bar channels is expected to occur, which, when combined with channel jetties, generally cause minor and localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The greatest effects from this are on the sediment starved coasts of Louisiana, where sediments are largely organic. These impacts would occur whether a CPA proposed action is implemented or not. A CPA proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in localized areas downdrift of artificially jettied and maintained channels.

A CPA proposed action may extend the life and presence of facilities in eroding areas, which could accelerate localized erosion. The strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas. With the established importance of barrier islands as frontline protection for both coastal wetlands and mainland infrastructure, there are no current or future plans for routing navigation channels (if needed) through barrier islands.

A large temporary increase in vessel traffic in the CPA resulted from the DWH event. Large numbers of specialty firefighting, dispersant, and skimmer vessels were concentrated around the Louisiana coast. Skimmers, tugboats, sand barges, and dredges comprised the bulk of the vessel traffic that was in near proximity to barrier islands as a result of berm construction. Due to the distance from the barrier islands and slow speed of these vessels, it is unlikely these vessels markedly increased erosion rates of these islands. As noted previously, the possibility of changes in current patterns as a result of sand mining and sediment placement, may affect natural island building. In the short term, these vessels and dredges have the potential to resuspend oiled bottom sediments that may exist in the area of these islands or mainland shorelines. However, it is doubtful that cumulative erosion that results from increased vessel traffic related to catastrophic spills would occur because the probability of catastrophic spills is small. This being the case, there should not be a sustainable cumulative increase in the need for supply and support vessels. This is because vessel traffic would either decrease or reach a state of equilibrium to meet the needs of the working wells. A CPA proposed action is estimated to contribute 2-3 percent of the total OCS traffic from 2012 through 2051 (**Tables 3-3 and 3-4**). Further details concerning vessel traffic can be found in **Chapter 3.1.1.8.4**. Navigation channels projected to be used in support of a CPA proposed action are discussed in **Chapter 3.1.2.1.8**.

Oil Spills

Sources and probabilities of oil entering waters of the Gulf and surrounding coastal regions are discussed in **Chapter 3.2.1**. Inland spills that do not occur in the vicinities of barrier tidal passes are more likely to contact the landward rather than the ocean side of a barrier island. Hence, no inland spills are expected to significantly contact barrier beaches (**Chapters 3.2.1.2.2, 3.2.1.7, and 3.2.1.8**).

Most spills occurring in offshore coastal waters are assumed to proportionally weather and dissipate before hitting the Louisiana coast. Dispersants are not expected to be used in coastal waters because response techniques discourage their use in coastal waters to protect habitat and species. No calculation has been made to estimate how much oil might be deposited on a beach if dispersants are not used. Favorable winds and currents could further diminish the volume of oil that might contact a beach. For example, a persistent, northwesterly wind might preclude contact. The strong winds (like those found with strong tropical storms) that would be needed to produce unusually high tide levels would also disperse the slick over a larger area than is considered in the current analysis. With the cumulative effect of successive hurricanes continually lowering the barrier and dune elevations and creating erosion pathways in mainland beaches, the probability of beach oiling increases. The probabilities of spill occurrence and contact with barrier beaches and sand-dune vegetation are considered low unless winds are sufficient to elevate tides over the now reduced barrier island elevations. Hence, contact of sand-dune vegetation by spilled oil is not expected to occur except in extreme storm conditions. Furthermore, the Mississippi River discharge would help dissipate a slick that might otherwise contact Plaquemines Parish, Louisiana. The mixing and spreading would reduce the oil concentrations contacting the beach and vegetation, greatly reducing impacts on vegetation.

Hurricanes and tropical storms will continue to erode and lower elevations of the barrier islands and to reduce their effectiveness as protection from inland oiling. While the probability of a catastrophic spill like the DWH event is low, it still has the potential to occur. As a result, some barrier islands could be oiled. Cleanup of these oiled islands and mainland beaches may involve utilizing heavy machinery that further impacts both beach and littoral habitats. Based on the current analysis associated with the DWH event, oil from offshore spills can lose many of its volatile and toxic components prior to onshore contact, which would render the residual beached oil low in PAH and other toxic compounds (OSAT-2, 2011). The form of the residual oil (i.e., tarballs, supratidal buried oil, or surfzone submerged oil mats) could affect its rate of weathering and biodegradation. Some oil may penetrate to depths beneath the reach of the cleanup methods. The remaining oil would persist in beach sands, periodically being released when storms and high tides resuspend or flush through beach sediments. Long-term stressors, including physical effects and the chemical toxicity of hydrocarbons, could lead to decreased primary production, plant dieback, and further erosion (Ko and Day, 2004b). The OSAT-2 report (2011) found a 86-98 percent depletion of PAH in the weathered samples that were beached. The buried supratidal samples underwent less biodegradation due to lack of oxygen, but they were estimated to decrease to 20 percent of current levels within 5 years (OSAT-2, 2011). The weathered oils measured in the beach sediment did not surpass any USEPA exceedances for aquatic wildlife, and the National Environmental Benefits Analysis performed by the OSAT (2010) determined that the residual oil remaining after cleanup efforts would be less damaging to the habitat and associated resources than continuing the cleanup effort.

Protective measures such as berm building (as discussed in the river channelization and beach protection section in this chapter) to prevent oiling may further impact barrier islands through increasing compaction, altering currents, and removing sand supplies needed for natural barrier island formation. The barrier beaches of Deltaic Louisiana have the greatest rates of erosion and landward retreat of any known in the western hemisphere, and among the greatest rates on earth. Long-term impacts to contacted beaches from these spills could occur if significant volumes of sand were removed during cleanup operations. Removing sand from the coastal littoral environment, particularly in the sand-starved transgressive setting of coastal Louisiana, could result in accelerated coastal erosion. Spill cleanup is difficult in the inaccessible setting of coastal Louisiana. This analysis assumes that Louisiana would require the responsible party to clean the beach without removing significant volumes of sand or to replace the sand removed. Hence, cleanup operations are not expected to cause permanent effects on barrier beach stability. Within a few months, adjustments in beach configuration may result from the disturbance and movement of sand during cleanup. Mechanized cleanup was used in Alabama and Florida to remove tarballs from recreational beaches. While sand was not removed, but sifted in place to remove tarballs, scientists acknowledge that until long-term monitoring results have been analyzed, it is too soon to determine if there will be long-term effects on specific interstitial organisms that live in the sands of the beach face.

The results of an investigation on the effects of the disposal of oiled sand on dune vegetation in Texas showed no deleterious impacts on existing vegetation or colonization of the sand by new vegetation (Webb, 1988). Hence, projected oil contacts to small areas of lower elevation sand dunes are not expected to result in destabilization of the sand dune area or the barrier landform.

The cumulative effect of aging infrastructure has the potential for increasing spills from older pipelines, platforms, and refineries. Typically, older pipelines are not as easily remotely monitored for potential problems or failures as the newer pipelines. The newer pipelines are manufactured to a more stringent safety standard and are constructed so that they may be easily inspected by instruments or manually. Spills are more likely to result from the older facilities, especially during storm conditions, because of the age of the pipeline or structure and the lack of newer superstructure designed to withstand major storms. To the extent that improperly abandoned and marked shallow-water wells exist in State waters, they may increase the potential for spills through vessel contact and leaks. Without closer monitoring and inspection by the states responsible for regulating State waters, the cumulative effect of the old improperly abandoned wells and infrastructure could potentially result in more frequent spills impacting barrier beaches and dunes.

Recreational Use and Tourism

Most barrier beaches in the CPA are relatively inaccessible for regular recreational use because they are either located a substantial distance offshore as in Mississippi or are in coastal areas with limited road access as in Louisiana. Few beaches in the CPA have been, or are likely to be, substantially altered to accommodate recreational or industrial construction projects in the near future.

Most barrier beaches in Alabama and Florida are accessible to people for recreational use because of road access, and their use is encouraged. Recreational use of barrier beaches and dunes can have impacts on the stability of the landform. Vehicle and pedestrian traffic on sand dunes can stress and reduce the density of vegetation that binds the sediment and stabilizes the dune. Destabilized dunes are more easily eroded by winds waves and traffic. Recreational vehicles and even hikers have caused problems where road access is available and the beach is wide enough to support vehicle use as in Alabama, Florida, and a few places in Louisiana. Areas without road access have limited impacts by recreational vehicles. A CPA proposed action would not provide any additional access that would result in an additive cumulative impact to the barrier beaches and dunes.

There will continue to be seaside real-estate development where road access is available. The protection of dunes, beaches, and coastal environments will be regulated through the Coastal Zone Management (CZM) program. This assures that projects are constructed consistent with the Federal CZM guidelines in order to preserve the integrity of the coastal ecosystem. Due to the continued occurrence of hurricanes, aging infrastructure, and proximity of some of the beaches to the oil production platforms, the possibility still exists of oil spills reaching recreational and barrier beaches. The potential for damage from oil cleanup can be minimized through utilizing nonintrusive removal techniques should the spill reach the shore.

Summary and Conclusion

River channelization, sediment deprivation, tropical and extra-tropical storm activity, sea-level rise, and rapid submergence have resulted in severe and rapid erosion of most of the barrier and shoreline landforms along the Louisiana coast. The barrier system of coastal Mississippi and Alabama is also supported on a coastal barrier platform of sand. Beach stabilization projects, such as groins and jetties, are considered by coastal geomorphologists and engineers to accelerate coastal erosion. Beneficial use of maintenance dredged materials and other restoration techniques could be required to mitigate some of these impacts.

The impacts of oil spills from both OCS and non-OCS sources to the sediment-deficient Louisiana coast should not result in long-term alteration of landforms, provided the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes. The barrier beaches of deltaic Louisiana and the Chenier Plain have the greatest risks of sustaining impacts from oil-spill landfalls because of the high concentrations of oil production near those coasts. However, the majority of inshore spills are assumed to be small in scale (77 bbl; **Chapter 3.2.1.7.1**) and short in duration; therefore, impacts would be minor. Oil from most offshore spills is assumed to be weathered and normally treated offshore; therefore, most of the toxic components have dissipated by the time it would contact coastal beaches. The cleanup impacts of these spills could result in short-term (up to 2 years) adjustment in beach profiles and configurations as a result of sand removal and disturbance during the cleanup operations. Some contact to lower areas of sand dunes is expected. These contacts would not result in significant destabilization of the dunes. All cleanup efforts would be monitored to ensure the least amount of disturbance to the areas. The long-term stressors to barrier beach communities caused by the physical effects and chemical toxicity of an oil spill may lead to decreased primary production, plant dieback, and further erosion. As found in the OSAT-2 report (2011) referenced above, the level of toxics found in buried or weathered oil on the beach or dune face should be evaluated prior to cleanup operations. The report noted that, in some cases, the toxic level was sufficiently low and would continue to decline; therefore, there was more risk of damaging habitat and biota from clean up than leaving the weathered oil in place.

Under the cumulative scenario, one new OCS-related and non-OCS pipeline landfalls are projected. These pipelines are expected to be installed using modern techniques, which cause little to no impacts to the barrier islands and beaches. Existing pipelines, in particular those that are parallel and landward of beaches, that were placed on barrier islands using older techniques and that left canals or shore protection structures have caused and would continue to cause barrier beaches to narrow and breach. A CPA proposed action projects 0-1 pipeline landfalls, and in the event that a pipeline landfall occurs, there would likely be no effect to barrier islands due to permitting and siting requirements and current construction techniques. Aging pipelines and infrastructure continue to be problematic, and the potential for spills could exist until they are replaced. Improperly abandoned wells can also have a potential to create spills, especially in the shallow State waters.

Recreational use of many barrier beaches in the WPA is intense due to their accessibility by road; however, because of the inaccessibility of most of the CPA barrier coast to humans, recreational use is not expected to result in significant impacts to most beaches. In conclusion, coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. Natural processes are generally considered the major contributor to these impacts, whereas human activities cause both severe local impacts and the acceleration of natural processes that deteriorate coastal barriers. Human activities that have caused the greatest adverse impacts are river channelization and damming, pipeline canals, navigation channel stabilization and maintenance, and beach stabilization structures. Deterioration of Gulf barrier beaches is expected to continue in the future. Federal, State (Louisiana), and parish governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines.

The SCAT maps and new data available since the DWH event that are incorporated into this EIS provide valuable information on the status of coastal barrier beaches and dunes that may have been impacted by the event. The BOEM acknowledges that there remains incomplete and unavailable information that may be relevant to reasonably foreseeable significant impacts on barrier beaches and associated dunes. This incomplete or unavailable information includes potential data on the DWH event that may be forthcoming. As there is substantial information available since the DWH event which is included in this EIS, BOEM believes that the incomplete or unavailable information regarding effects of the DWH event on coastal barrier beaches and dunes would likely not be essential to a reasoned choice among alternatives. The bulk of this information is expected to be developed through the ongoing NRDA process. To date, relatively little raw data have been released publicly by the NRDA process, and it may be years before studies are completed and results are released. This information will certainly not be available within the timeframe contemplated by this NEPA analysis. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. BOEM subject-matter experts have used what scientifically credible information is available in their analyses, applied using accepted scientific methodology. Compared with the historic and ongoing threats to coastal barrier beaches and dunes, such as development threats, natural factors such as hurricanes, and channelization, any remaining effects of the DWH event on coastal barrier beaches and dunes is expected to be small.

A CPA proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in localized areas downdrift of artificially jettied and maintained channels. A CPA proposed action may extend the life and presence of facilities in eroding areas, which would accelerate erosion in those areas. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions could mitigate adverse impacts upon those localized areas. A CPA proposed action is not expected to increase the probabilities of oil spills beyond the current estimates. Thus, the incremental contribution of a CPA proposed action to the cumulative impacts on coastal barrier beaches and associated dunes is expected to be small.

4.2.1.4. Wetlands

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this EIS. A summary of those analyses and their reexamination due to new information and in consideration of the DWH event is presented in the following sections. A brief summary of potential impacts follows. Effects to coastal wetlands from the primary impact-producing activities associated with a CPA proposed action are expected to be low. The primary impact-producing activities associated with routine activities for a CPA proposed action that could affect wetlands include pipeline emplacement, construction and maintenance, navigational channel use (vessel traffic) and maintenance, disposal of OCS energy-related wastes, and use and construction of support infrastructure in these coastal areas. Vessel traffic associated with a CPA proposed action is expected to contribute minimally to the erosion and widening of navigation channels and canals. Deltaic Louisiana is expected to continue to experience the greatest loss of wetland habitat, primarily from sources unrelated to OCS energy production. Wetland loss is similarly expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates. The incremental contribution of a CPA proposed action to the cumulative impacts on coastal wetlands is expected to be very small.

Routine activities in the CPA such as pipeline emplacement, navigational channel use, maintenance dredging, disposal of OCS wastes, and construction and maintenance of OCS support infrastructure in coastal areas are expected to result in low impacts. Indirect impacts from wake erosion and saltwater intrusion are expected to result in low impacts, which are indistinguishable from direct impacts from inshore activities. The potential impacts from accidental events, primarily oil spills, are anticipated to be minimal. The incremental contribution of a CPA proposed action's impacts to the cumulative impacts to wetlands is small and expected to be negligible.

4.2.1.4.1. Description of the Affected Environment

The current evaluation of wetland trends in the U.S. covering the period from 1998 to 2004 indicated that there were slightly more than 5.3 million ac (2.1 million ha) of marine and estuarine wetlands in the conterminous United States (Dahl, 2006). Eighty-six percent of that total area was vegetated wetland. The intertidal and estuarine components of these vegetated wetlands declined by an estimated 28,416 ac (11,580 ha) and 32,400 ac (13,120 ha), respectively, between 1998 and 2004. Estuarine nonvegetated wetlands experienced a net gain of an estimated 4,000 ac (1,620 ha); marine intertidal shorelines declined. While there was an overall net gain in wetlands acreage nationally in wetland acreage between 1998 and 2004, coastal Louisiana, which contains about 37 percent of the estuarine herbaceous marshes in the conterminous United States and which supports the largest commercial fishery in the lower 48 States, currently accounts for about 90 percent of the total coastal wetland loss in the continental United States (Couvillion et al., 2011). These analyses show that coastal Louisiana has undergone a net change in land area of about -1,883 mi^2 (-4,877 km^2) from 1932 to 2010. This net change in land area amounts to a decrease of about 25 percent of the 1932 land area. Ninety-five percent of this loss is due to continual loss of land through subsidence, saltwater intrusion, etc. The remaining open-water areas are in potential transition back to marsh, but it is too early to tell if these marshes have been lost through conversion to open water or have converted to open water and are still transitioning from scour-induced open water that may return as marsh. Trend analyses from 1985 to 2010 show a wetland loss rate of 16.57 mi^2 (42.92 km^2) per year (Couvillion et al., 2011). If this loss were to occur at a constant rate, it would equate to Louisiana losing an area the size of one football field per hour. The use of 17 datasets plus the application of consistent change criteria in Couvillion's study provide opportunities to better understand the timing and causal mechanisms of wetland loss that are critical for forecasting landscape changes in the future.

The importance of coastal wetlands to the coastal environment has been well documented. One of the important functions of coastal marshes and barrier islands is as a front line of defense against storm surge. High organic productivity and efficient nutrient recycling are characteristic of coastal wetlands. These wetland corridors provide habitat for a great number and wide diversity of resident plants, invertebrates, fishes, reptiles, birds, and mammals. Marsh environments are particularly important nursery grounds for many economically important fish and shellfish juveniles. The marsh edge, where marsh and open water come together, is particularly important for its higher productivity and greater concentrations of organisms. Emergent plants produce the bulk of the energy that supports salt-marsh dependent animals. The description of the wetlands resources that follows includes the historical types and location of the various wetland resources, the existing condition of these resources after several years of unprecedented hurricane activity, and possible effects from exposure of these resources to oil (based on current publicly available data) from the DWH event.

In general, coastal wetland habitats occur as bands around waterways. They are broad expanses of saline, brackish, and freshwater marshes; mud and sand flats; forested wetlands that consist of cypress-tupelo swamps; and mangrove and bottomland hardwood forests. Saline and brackish habitats support sharply delineated and segregated stands of single plant species. Fresh and low-salinity environments support more diverse and mixed communities of plants.

General Existing Condition of Louisiana Coastal Wetlands

According to the U.S. Department of the Interior, during the mid-1980's, 28 percent of Louisiana (3,557,520 ha; 8,790,823 ac) was considered wetlands (Dahl, 1990; Henfer et al., 1994). Wetland loss rates in coastal Louisiana are well documented to have been as high as 10,878 ha/yr (42 mi^2/yr) during the late 1960's. Studies have shown that the landloss rate in coastal Louisiana for the period 1972-1990 slowed to an estimated 6,475 ha/yr (25 mi^2/yr) (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993). Over the next 50 years, Louisiana is projected to lose almost 17 mi^2/yr (4,403 ha) of coastline due to storms, sea-level rise, and land subsidence (Government Accountability Office, 2007). A recent evaluation of landloss rates suggests that landloss is not occurring as rapidly as previously estimated and that it has been relatively stable from the 1970's through 2004 (Barras et al., 2008). Barras et al. (2008) states that, during 1985-2004, the majority of the coastal landloss occurred on the Deltaic Plain at a rate of 3,885-4,144 ha/yr (15-16 mi^2/yr). For the same period, the Marginal Deltaic Plain showed a slight increase in land at a rate of 155 ha/yr (0.6 mi^2/yr) as a result of the growth of the Atchafalaya River and Wax Lake Delta Complexes. However, the Chenier Plain loss rate remained fairly stable at 518 ha/yr (2 mi^2/yr). The overall rate of coastal landloss between 1985 and 2004 was approximately 3,108 ha/yr (12 mi^2/yr). Annual rates of coastal landloss for 1985-2006 increased from 777 ha/yr (3 mi^2/yr) to 3,885 ha/yr (15 mi^2/yr), relative to the 1985-2004 trends. This 777 ha/yr (3 mi^2/yr) increase reflects the hurricane-induced acceleration of landloss. To demonstrate the effects of Hurricanes Katrina and Rita, the study also analyzed the loss rates between 2004 and 2006. During this period, open water (indicates landloss) increased coastwide by 51,282 ha (198 mi^2), the equivalent of 70 percent of the cumulative loss from 1978 to 2004. Hurricanes Katrina and Rita increased open water in coastal Louisiana by 56,720 ha (219 mi^2) between 2004 and 2005. However, between 2005 and 2006 recovery increased the land base by 5,439 ha (21 mi^2) in a short period of time. The land gain between 2005 and 2006 is equal to approximately 10 percent of the landloss (56,203 ha; 217 mi^2) estimated for 2004-2005 (Barras, 2006).

Chenier Plain

The Chenier Plain formed between Port Bolivar, Texas, and Atchafalaya Bay in Louisiana as a result of storms and tidal currents reworking and depositing the sediments of the Mississippi River and its delta over the past several thousand years. As a result, few tidal passes are found along this coast as compared with eastern Louisiana. This reduction in the tidal passes reduces movement of saline waters. As the area filled in, a series of shell and sand ridges formed parallel or oblique to the present-day Gulf Coast, and these ridges were later abandoned as sea level continued to fall. Mudflats formed between the ridges when localized hydrologic and sedimentation patterns favored deposition (summarized from USDOI, GS, 1988). This intermittent deposition isolated entrenched valleys from the Gulf, forming large lakes such as Sabine, Calcasieu, White, and Grand (Gosselink et al., 1979; Fisher et al., 1973). The eastern Chenier Plain that comprises the Calcasieu/Sabine Basin in Cameron and Calcasieu Parishes (southwest Louisiana) is approximately 630,000 ac (254,952 ha). This Basin contains about 312,500 ac (126,464 ha) of wetlands consisting of 32,800 ac (13, 274 ha) of fresh marsh, 112,000 ac (45,325 ha) of intermediate marsh, 158,200 ac (64,021 ha) of brackish marsh, and 9,500 ac (3,845 ha) of saline marsh (LaCoast.gov, 2010c). A total of 122,000 ac (49,373 ha) (28%) has been lost since 1932. Calcasieu and Sabine Lakes are the major waterbodies within the basin, and freshwater inflow to the basin occurs primarily through these lakes via the Calcasieu and Sabine Rivers. Marshes within the basin historically drained into these two large lakes. The Chenier Plain supports an extensive marshland interspersed with large inland lakes formed in river valleys that were drowned after the last glaciation (Mac et al., 1998). Brackish and intermediate salinity marshes are dominant in the estuarine areas of the Chenier Plain. They are tidal with wind-driven tides being more influential, and they occasionally inundate these areas. Since salinity in this area ranges broadly, these habitats support a mix of marine and salt-tolerant freshwater plants with marsh-hay cordgrass (*Spartina patens)* generally dominant. These habitats are the most extensive and productive in coastal Louisiana.

Freshwater wetlands are extensive in the Chenier Plain due to the abundant rainfall and runoff, coupled with a ridge system that retains freshwater and restricts the inflow of saline waters. Plant communities of freshwater marshes are among the most diverse of sensitive coastal environments. Annuals have a much greater presence in freshwater marshes than in estuarine areas. Dominance changes from season to season as a result of year-round, seed-germination schedules. Tidal influences are minimal in these areas, although strong storms may inundate the area. This could either raise the salinity from seawater coming in or lower the salinity with increased precipitation. Depending on the species, this could case salinity and flooding stress. Detritus is not as readily exported and accumulates in the Plain, and it supports additional plant growth. Freshwater marsh plants are generally more buoyant than estuarine plants. In areas where detritus is thick, marsh plants may form floating marshes (flotants). Flotants occur in very low-energy environments. They are held together by surrounding shorelines and a weave of slowly deteriorating plant materials and living roots. Forested wetlands only occur in the flood plain regions of major streams, along the northern margin of the Chenier Plain. There, cypress-tupelo swamps grade through stands of black willow to bottomland hardwoods (LaCoast.gov, 2010c).

Subsidence and sea-level rise are natural processes that contribute to wetland deterioration, but under pristine conditions, marsh building and maintenance processes can maintain the coastal marshes through normal subsidence and sea-level rise. The combination of subsidence and sea-level rise in the Calcasieu/Sabine Basin is approximately 0.25 in/yr (6 mm/yr) (LaCoast.gov, 2010c). However, due to manmade alterations to the basin hydrology, the natural wetland-building process no longer occurs at its historic rate. These factors, in combination with tropical storms, continue to deteriorate the Chenier Plain. In the Sabine Basin, the natural wetland-building processes no longer occur, but natural marsh maintenance processes can be fairly effective at keeping wetland loss rates low. As noted in the section above ("General Existing Condition of Louisiana Coastal Wetlands"), the Chenier Plain loss rate remained fairly stable at 518 ha/yr (2 mi^2/yr) between 1985 and 2004, while other areas of coastal Louisiana deteriorated rapidly (Barras et al., 2008).

The Louisiana coast was impacted by a series of successive Category 3 and 5 hurricanes between 2005 and 2008. The Chenier Plain was subjected to extreme flooding and erosion along the coastal beaches and marshes. While it is too early to quantify the damages incurred to the existing resource, further discussion of the storms' effects can be found in the "Hurricanes" section below. In addition to these natural effects, the coastline and the adjacent wetlands were exposed to oil from the DWH event, which occurred off the Louisiana coast in April 2010. The portion of the Chenier Plain previously exposed to oil from the DWH event is currently identified as oil free, with no oil observed from the Texas/Louisiana border through the Atchafalaya Basin in Louisiana (USDOC, NOAA, 2011f [ERMA, September 28, 2011]).

Mississippi River Delta Complex

The Mississippi River Delta Complex forms a plain that is composed of a series of overlapping riverine deltas that have extended onto the continental shelf over the past 6,000 years. Wetlands on this deltaic plain are the most extensive of those within the northern Gulf of Mexico. Sparse stands of black mangrove are found in the highest salinity areas of the Barataria and Terrebonne Basins. Extensive salt and brackish marshes are found throughout the southern half of the plain and east of the Mississippi River. Further inland, extensive intermediate and freshwater marshes occur. East of the Mississippi River and south of Lake Pontchartrain, Louisiana, very few intermediate and freshwater wetlands occurred until the Caernarvon Freshwater Diversion was intermittently put into action in 1993. In freshwater areas, cypress-tupelo swamps are found flanking the natural levees and in areas that are impounded by dredged materials, levees, or roads. Bottomland hardwoods are on the numerous natural levees and in drained levee areas (USDOI, MMS, 2007c).

Except for leveed areas and the delta and basin of the Atchafalaya River, all of the Mississippi River deltas are generally experiencing succession towards wetter terrestrial and deeper water habitats. This is due to deltaic abandonment (which is historically naturally occurring, but has been altered by anthropogenic actions recently) and human actions and their ensuing erosion. Most of these wetlands are built upon highly organic soils that are easily eroded, compacted, and oxidized. There are two actively building deltas in this area. The more active is in Atchafalaya Bay at the mouths of the Atchafalaya River and its distributary, Wax Lake Outlet. Because the Red River and approximately 30 percent of the Mississippi River have been diverted to the Atchafalaya River, large volumes of sediment are being delivered to the shallow bay. As a result, extensive freshwater marshes, swamps, and bottomland hardwood forests are found in this river basin, and relatively few estuarine marshes.

The less active delta is at the mouth of the Mississippi River, which is referred to as the Belize or Birdfoot Delta. The Mississippi River has been channelized through most of this delta. This channelization greatly reduced the volume of sediments that the River contributes to its delta and the longshore currents near the mouths of its distributaries. A few manmade diversions have been installed and others are in the planning stage. Diversions are designed to deliver water rather than sediments to this delta. However, through the Louisiana Coastal Wetlands Planning, Protection and Restoration Act Program (LaCoast.gov, 2010a), projects are being either planned or designed to provide not only additional freshwater diversions but also sediment delivery projects that are intended to assist in creating and restoring marshes in the Mississippi Deltaic Plain (LaCoast.gov, 2010b). Some of these projects include manmade crevasses in the Mississippi River levee. Examples are the Delta Wide Crevasse project, which is intended to create marsh; the Mississippi Channel Armor Gap and West Bay projects, which are designed as sediment and water diversions; and the Barneys Bay Diversion, which is intended to provide water and sediment to the disappearing marsh zones (LaCoast.gov, 2010b). The State of Louisiana is also utilizing dustpan dredges in these areas for deposition of sediment to these sediment-starved areas of the coast. Smaller shoreline regressions also occur as a result of jetties located on the eastern end of Grand Isle, the western end of Caminada-Moreau Beach, the Empire Navigational Canal, and elsewhere.

Most dune zones of the Mississippi River Delta contain low, single-line dune ridges that may be sparsely to heavily vegetated. Generally, in this area the vegetation on dune ridges gets denser as the time between storms increases. The shorefaces of the Mississippi River Delta Complex generally slope very gently seaward, which reduces wave energies at the shorelines. Mud flats are exposed during very low tidal events. The slope here is not as shallow as that found off the Chenier Plain. The steepest shoreface of the delta is found at the Caminada-Moreau Coast, where the greatest rates of erosion are seen. At this site, the longshore currents split to the east and west, which removes sand from the area without replenishment (Wolfe et al., 1988; Wetherell, 1992; Holder and Lugo-Fernandez, 1993).

Unfortunately, the past decade has seen an increase in tropical storm activity for the GOM. Hurricane Katrina (August 2005) caused severe erosion and landloss for the coastal barrier islands of the Deltaic Plain. Currently, the intense hurricane activity in the Gulf over the past 6 years has accelerated either wetland loss or changes in composition or pattern of wetland vegetation in the area. This has occurred with the help of both manmade and storm-induced changes in hydrology (Steyer et al., 2008), which have resulted in salinity changes and the removal of protected headlands or beaches. Further discussion of changes in the delta hydrology and damages to wetlands from Hurricanes Katrina, Rita, Ike, and Gustav can be found under the “Hurricanes” section below.

Aside from the effects of these tropical storms, the Mississippi River Delta Complex and the majority of the Louisiana coast were exposed to some degree of oiling from the DWH event. Based on the review of currently available SCAT maps (USDOC, NOAA, 2011f [ERMA, September 28, 2011]) and field observations, the majority of the shoreline from the Atchafalaya Delta to the Mississippi River Delta, with the exception of the Bay Jimmy, is currently either categorized as not oiled or with small areas (2.8 km; 1.8 mi) that have a mixture of no oil and lightly oiled (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). In the Bay Jimmy area as described above (“General Existing Conditions of Louisiana Coastal Wetlands”), there are some remnants of heavy to moderate oiling in the fringe marshes along interior canals and inland cove shorelines of the backside and gulf side islands that form Bay Jimmy. Only some of the NRDA data is publicly available, and there are currently no publicly available NRDA data analyses or interpretations. Therefore, the effects of the oil exposure can only be discussed with publicly available data such as the OSAT and OSAT -2 reports (2010 and 2011) and publicly available independent research reports.

Findings of the OSAT and OSAT-2 reports (2010 and 2011) provide insight as to the condition of the weathered oil that reached the shoreline. The weathered samples collected showed 86-98 percent depletion of total PAH (OSAT-2, 2011). It was also noted that since August 2010 there have been no USEPA exceedances for aquatic life benchmarks in sediment or water samples, including those samples taken near beaches and inland. Sediment contamination was limited to areas up to 3km (~2mi) from the wellhead of the DWH event (OSAT, 2010). In most locations, the modeling results indicate that PAH concentrations will decrease by 20 percent of their current level (OSAT, 2010). The DWH event was a deep-sea spill under high pressure. Therefore, the oil released underwent rapid dispersion and dilution, so it was in a form available for biodegradation (Atlas and Hazen, 2011). Over 40 percent of the oil was lost between the wellhead and the surface due to dissolution, mixing, and evaporation once it reached the surface. Surface oil analysis indicated that the volatile organic compounds were dissolved or evaporated before reaching shore (Atlas and Hazen, 2011). Even though the oil reaching vegetated shorelines had been greatly reduced in toxicity, the lack of oxygen in marsh soils may require a longer time for complete weathering through biodegradation to occur.

Oiled shorelines along Bay Jimmy in Barataria Bay and the Birdsfoot Delta of the Mississippi River were evaluated for effects related to the DWH event (Kokaly et al., 2011). Findings of the Kokaly et al. study indicate that the Bay Jimmy area was dominated by *Spartina alterniflora* and *Juncus roemerianus* marsh grasses, which are both short in height and susceptible to being fully oiled depending on tidal conditions (Kokaly et al., 2011). The average inland or "oil-damage penetration zone" in this area extended inland to 6.7 m (22 ft); however, the maximum "oil-damaged penetration zone" was up to 19 m (62 ft) inland in some areas. In the Barataria Bay, oil effects on vegetation ranged from lightly oiled sections of stems to oil-damaged canopies. There were also broken stems due to incoming surface oil on higher tides (Kokaly et al., 2011). In the Birdsfoot Delta the predominant marsh grass is taller and less susceptible to complete oiling; thus, vegetative damage appears minimized. Indicators of both further degradation and recovery were seen at both Barataria Bay and Birdsfoot Delta. Some wetlands showed great reductions in live vegetation and evidence of sediment erosion. However, in other wetlands, damaged zones had signs of growth and recovery. This was evident with regrowth of vegetation of up to 10 percent of the area assessed (Kokaly et al., 2011). Further study is being initiated to determine if the underground root mass sustains a more complete recovery of these marshes.

Mississippi and Alabama

According to DOI, during the mid-1980's, 14 percent of Mississippi and 8 percent of Alabama were considered wetlands (Dahl, 1990; Henfer et al., 1994). Historically, vegetated coastal wetlands along the Mississippi coast included salt and brackish marshes, tidal freshwater marshes and swamps, and submerged aquatic vegetation beds. Between 1930 and 1973, approximately 8,170 ac (3,308 ha) of coastal marshes were filled for industrial and residential uses.

It was estimated in 1973 that Mississippi contained over 66,108 ac (26,764 ha) of salt marshes and approximately 823 ac (33 ha) of freshwater marshes (Mississippi Dept. of Marine Resources, 1999). Today, Mississippi has approximately a total of 72,000 ac (113 mi^2) of designated crucial coastal wetland habitat (Mississippi Dept. of Marine Resources, 2006). Bottom-land forests, swamps, and fresh marshes account for most of Mississippi's wetland acreage. Estuarine wetlands are the second most common wetlands in Mississippi and could include marshes, mud flats, and forested wetlands. The estuarine marshes around Mississippi Sound and associated bays occur in discontinuous bands. The most extensive wetland areas in Mississippi occur in the eastern Pearl River delta near the Louisiana/Mississippi border and in the Pascagoula River delta area near the Mississippi/Alabama border. Mississippi's wetlands seem to be more stable than those in Louisiana and Alabama, perhaps reflecting the more stable substrate, active and less disrupted sedimentation patterns, and occurrence of only minor canal dredging and development. Urban and suburban growths are suggested as the greatest contributors to direct coastal wetland loss in Mississippi and Alabama. Mississippi had a loss with the original 10 million ac (4 million ha) of marshes in the 1780's dwindling to approximately 4 million ac (1.6 million ha) by the 1900's, representing a 59 percent loss (Dahl, 1990). Coastal Mississippi is predominantly salt marsh habitat with very little fresh marsh. The observed loss rates in coastal Mississippi reflect this discrepancy in habitat with losses of 64,000 ac (25,900 ha) of salt marsh and only 800 ac (324 ha) of fresh marsh (Swann, n.d.).

The Gulf Coast of Alabama extends the length of the state, a distance of only 74 km (46 mi) (Alabama Coastal Area Board, 1980). The coastline includes the estuaries and inlets that cover a greater distance of 981 km (610 mi) (Horn, 2006). Two large drainage basins empty into the northern Gulf of Mexico within coastal Alabama; they are the Perdido River Basin and the Mobile River Basin. The Perdido Basin encompasses 3,238 km^2 (1,250 mi^2) of Alabama and Florida (Sturm et al., 2007). The Mobile Basin is the sixth largest drainage area and the fourth largest river basin in terms of flow volume in the United States. The 111,370-km^2 (43,000-mi^2) Mobile Basin encompasses parts of Tennessee, Georgia, Mississippi, and Alabama (Isphording and Flowers, 1990; Johnson et al., 2002).

The coastal lowlands of Alabama, with gently undulating to flat topography, basically follow the shoreline along the Gulf of Mexico and Mobile, Perdido, and Bon Secour Bays (Sapp and Emplaincourt, 1975). The ecological environments and geomorphology consist of features such as wetlands (e.g., tidal marsh), two large peninsulas, a delta, lagoons, islands, and bays. The presence of a high water table with a range of salinities gives rise to the abundance of various wetland habitat types that are found within Alabama's coastal area. The largest bays of coastal Alabama stated in size order include Mobile Bay, Perdido Bay, and Bon Secour Bay. The largest of these is Mobile Bay and it was formed within a submerged river valley (Chermock, 1974). A portion of Perdido Bay is also in Florida and contains areas populated by seagrasses. The Mississippi Sound estuary, located behind the offshore barrier islands, extends from southwestern Mobile Bay and borders the entire southern Mobile County and Mississippi coastlines. The Mobile, Tensaw, and Blakeley Rivers flow southward to Mobile Bay through the Mobile-Tensaw Delta. The alluvial-deltaic plain is located at the terminus of Mobile Bay to northward along the Mobile-Baldwin County line. Topographically, the Mobile-Tensaw Delta is flat and generally below 6 m (20 ft) in elevation. Additionally, other major coastal tributaries include Dog and East Fowl Rivers on the western side of Mobile Bay and the Blakeley, Fish, Magnolia, and Bon Secour Rivers on the eastern side of the Bay. West Fowl and Escatawpa Rivers discharge into Mississippi Sound, and the Perdido and Blackwater Rivers are located at the northern end of Perdido Bay. Alabama has approximately 118,000 ac (184 mi^2) of coastal wetlands, of which approximately 75,000 ac (117 mi^2) are forested; 4,400 ac (9 mi^2) are freshwater marsh; and 35,400 ac (55 mi^2) are estuarine marsh (Wallace, 1996). Most coastal wetlands in Alabama occur on the Mobile River Delta or along the northern Mississippi Sound. In Alabama, approximately 15,000 ac (6,070 ha) of salt marsh were lost as opposed to 11,000 ac (4,452 ha) of fresh marsh. Based on historical records, Alabama had approximately 7.6 million ac (3.1 million ha) of marsh in the 1780's and, by the 1980's, was left with 3.6 million ac (1.5 million ha), representing a 50 percent loss in marsh acreage.

Both Mississippi and Alabama have estuarine intertidal emergent habitats that include salt marsh, as well as intertidal forested shrub that can include mangroves and other salt tolerant shrubs. The embayments and shallow-water environments in these coastal waters also have estuarine aquatic beds that may include submergent or floating vegetation (Swann, 2010). The existing conditions associated with channel maintenance (dredging and filling), bank armoring, vessel wakes, propeller wash, coastal development, subsidence, and sea-level rise will continue as part of sources aggravating the loss of coastal marshes. Federal and State coastal initiatives (e.g., CIAP and CWPPRA) are either ongoing or being expanded to restore, protect, or construct wetlands and further prevent coastal wetland loss. Overall coastal wetlands in these areas have been greatly reduced to approximately 50 percent of historical values. The sparse data available since the 1980's suggest that losses have slowed (Swann, n.d.). Another important factor in wetland loss over the past 6 years has been the extremely active hurricane season.

These natural forces, along with the currently unknown long-term effects of the DWH event, may further affect the sustainability of these coastal marshes. There were 9 and 81 mi (14 and 130 km), respectively, of shoreline in Mississippi exposed to either heavy or light shoreline oilings by October 2010. The SCAT observations are not indicating any moderate to heavy oil exposure along the Alabama shoreline, but some light oiling was noted along 60 mi (97 km) of shoreline. Florida had no heavily oiled shoreline as of the October 2010 report date, but 114 mi (183 km) of light to traces of oil were found along the Alabama shoreline at that time. Based on the review of the September 28, 2011, SCAT maps (USDOC, NOAA, 2011f [ERMA]) and observations, no oil was observed along the Mississippi coastline with the exception of small amounts of lightly oiled bayside beaches of the outer barrier islands of Ship, Horn and Petit Bois. There were very small (less than a mile) areas of moderate oiling on the back side of both Horn and Petit Bois Islands. These beaches are currently being cleaned. The September 28, 2011, SCAT maps (USDOC, NOAA, 2011f [ERMA]) and observations are likewise not identifying any Alabama coastline as showing any oiling. While NRDA findings are still not publically available, there is now more known about the fate and condition of this oil based on the OSAT reports (2010 and 2011). The OSAT report noted that, since August 2010, there have been no exceedances for USEPA aquatic life benchmark for PAH's in either sediments or water sampled at distances >3 km (~2 mi) from the DWH well head (OSAT, 2010). In addition, it was noted that 86-98 percent of the total PAH was depleted during the weathering process while being transported to shore.

Hurricanes

The intensity and frequency of hurricanes in the Gulf over the last decade has greatly impacted the system of protective barrier islands, beaches, and dunes and associated wetlands along the Gulf Coast. Within the last decade, the Gulf Coast of Texas, Louisiana, Mississippi, Alabama, and to some degree Florida have experienced five major hurricanes (Ivan, Katrina, Rita, Gustav, and Ike). As a result of losing dune and barrier island elevations, as well as associated marshes and backshore and foreshore wetlands, the inland coasts and wetlands are more vulnerable to future hurricanes and wind-driven tidal or storm events.

The post-Hurricanes Katrina and Rita estimates of land change made by USGS (Barras, 2006) indicated that there was an increase of 217 mi^2 (562 km^2) of open water following the storm. Based on the analysis of the latest satellite imagery (Barras, 2007b), approximately 82 mi^2 (212 km^2) of new open-water locations were in areas primarily impacted by Hurricane Katrina (e.g., Mississippi River Delta Basin, Breton Sound Basin, Pontchartrain Basin, and Pearl River Basin), whereas 99 mi^2 (256 km^2) were in areas primarily impacted by Hurricane Rita (e.g., Calcasieu/Sabine Basin, Mermentau Basin, Teche/Vermilion Basin, Atchafalaya Basin, and Terrebonne Basin). The Barataria Basin contained open-water locations caused by both Hurricanes Katrina and Rita, resulting in some 18 mi^2 (46.6 km^2) of open water. The fresh and intermediate marsh land decreased by 122 mi^2 (316 km^2) and 90 mi^2 (233.1 km^2), respectively. The brackish and saline marsh land decreased by 33 mi^2 (85.5 km^2) and 28 mi^2 (72.5 km^2), respectively. Based on current observational flights by USGS, wetland recovery 6 years after Hurricane Katrina is noted as slow (Israel, 2010), with open water remaining where viable marshes once existed. The marshlands east of the Mississippi Delta were the most severely affected. According to the USGS's 5-year, post-Katrina survey, the wetland loss from all four storms (i.e., Hurricanes Katrina, Rita, Gustav, and Ike) totaled 340 mi^2 (881 km^2). Hurricanes Katrina and Rita alone destroyed 220 mi^2 (570 km^2) (Israel, 2010).

Intense storms typically blow away all of the vegetation and soil from marsh, leaving behind a body of water. Hurricane Katrina was no exception, leaving scour holes where debris accelerated by the storm pushed the marsh away. Based on the depths of these scours, marsh type (i.e., fresh, intermediate, brackish, or saline), sediment supply, and drainage, possible recovery time is determined. However, it is too early to determine if long-term recovery is viable. Another factor that is now superimposed on the hurricane damage is the currently unknown, long-term effect of the oil spill from the DWH event. All of these factors must now be considered as part of the existing environment.

Deepwater Horizon Event

On April 20, 2010, the DWH event resulted in the largest oil spill in the history of the U.S. The oil continued to flow for 87 days before the well was capped. It is estimated that a total of approximately 4.9 MMbbl of oil were released from the well. This spill initially oiled shorelines along the Louisiana coast from extreme western Louisiana to portions of the Mississippi coast. Most of the Louisiana coast was exposed to some degree of oiling, ranging from light to heavy, and the oil has at least temporarily degraded the quality of certain areas of wetland habitat. The information provided in this EIS is from the best publicly available information that could be acquired. With regards to the DWH event, the data from the SCAT observations, as compiled in the Unified Command Daily Report for October 12, 2010, indicated that, as of that date, 88.8 mi (142.9 km) of Louisiana were heavily oiled and 203.1 mi (326.9 km) of shoreline had light to traces of oil observed. A review of September 2011 SCAT maps (USDOC, NOAA, 2011f [ERMA, September 28, 2011]) indicates that the coastline from the Louisiana/Texas State line (Sabine) to Panama City, Florida, continues to improve and is being categorized as shoreline with no oiling to lightly oiled, with the exception of the Bay Jimmy area in southeastern Louisiana. From Cameron, Louisiana, east to Terrebonne Bay there was either no oil or small patches of light oiling along the Isle Dernieres and the Terrebonne Bay shoreline. There were also small patches of marsh in Terrebonne Bay that were lightly oiled. Moving farther east, the shoreline adjacent to Barataria Bay only had trace to light oiling observed, with the exception of the initially heavily oiled Bay Jimmy area. The marsh fringe on the back side of the two large Gulfward islands forming the entrance to Bay Jimmy are currently not oiled to lightly oiled. Approximately 2 km (1.2 mi) of the shorelines along the interior canals of these islands are still categorized as heavily oiled and are currently undergoing evaluation for further cleaning (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). The island forming the western shore of Bay Jimmy varies from having no observed oil to having observations of light to very light oil, and it only has small patches of moderate to heavily oiled shoreline. Approximately 1.6 km (1 mi) of marsh bordering the eastern cove of the island that creates the back side of Bay Jimmy also remains heavily oiled (USDOC, NOAA, 2011f [ERMA, September 28, 2011]). The oil penetration in these marshes is estimated to be 5.5 m (18 ft) inland (Kokaly et al., 2010). While the SCAT maps graphically depict 5.7 km (3.5 mi) of shoreline as heavily oiled, in most cases, this represents only the area surveyed and not necessarily the total amount of area oiled.

As noted above, BOEM recognizes that there remains incomplete and unavailable information related to wetlands, including impacts from the DWH event. Here, BOEM concludes that the unavailable or incomplete information may be relevant to foreseeable significant adverse impacts to wetlands. Relevant data on the status of wetlands and marshes after the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. The NRDA process is ongoing, and to date, much of the information collected as part of the process has not been fully analyzed and conclusions have not been released to the public. It may be years before NRDA data and conclusions are available. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches. Nevertheless, BOEM believes that incomplete or unavailable information regarding unknown effects of the DWH event is not essential to a reasoned choice among alternatives. Although there may still be incoming information, there is significant available data on shoreline oiling and the current status of wetlands and marshes from the SCAT and ERMA databases that have assisted BOEM subject-matter experts in their analyses. Future incoming data are not expected to significantly alter these conclusions, and future impacts from these past events are not expected.

4.2.1.4.2. Impacts of Routine Events

Background/Introduction

Impact-producing factors and scenarios for routine operations can be found in **Chapter 3.1**. In this section, consideration is given to impacts to coastal wetlands and marshes from routine activities associated with a CPA proposed action. The primary impact-producing activities associated with a CPA proposed action that could affect wetlands and marshes include pipeline emplacement, construction, and maintenance; navigation channel use (vessel traffic) and maintenance dredging; disposal of OCS-related wastes; and use and construction of support infrastructure in these coastal areas. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigational traffic, levee construction that prevents necessary sedimentary processes, saltwater intrusion that changes the hydrology leading to unfavorable conditions for wetland vegetation, and vulnerability to storm damage from eroded wetlands. The following sections describe the sources and types of these potential impacts. In addition to the above effects, the DWH event oil spill presents other potential indirect effects, in the event of disturbed remnant oil in the sediment. It is highly unlikely that the remnant oil is toxic due to weathering time, biological degradation, and dispersant treatment.

Pipeline Emplacement

The scenario for this EIS projects the installation of 628-1870 km (390-1,162 mi) of pipelines in Federal offshore lands associated with a typical CPA proposed action and a projected 25,204-57,177 km (15,661-35,528 mi) of pipeline installation in the CPA over the 40-year life of the proposed lease sale (**Tables 3-3 and 3-6**). Many OCS pipelines make landfall on Louisiana’s barrier island and wetland shorelines. Approximately 8,000 km (4,971 mi) of OCS-related pipelines cross marsh and uplands (USDOI, MMS, 2007c, p. 4-314; Johnston et al., 2009). Louisiana wetlands protect pipelines from waves and ensure that the lines stay buried and in place. Existing pipelines, especially those installed prior to the State of Louisiana Coastal Permit Program in 1981, have caused direct landloss averaging between 2.5 and 4.0 ha (10 and 16 ac) per linear mile of pipeline (Bauman and Turner, 1990; Johnston et al., 2009) Bauman and Turner (1990) indicated that the widening of OCS pipeline canals does not appear to be an important factor for total net wetland loss in the coastal zone because few pipeline canals are open to navigation.

Since 2002, only one new pipeline has come to shore in Louisiana from OCS-related activities. In 2003, the 30-in Endymion Oil Pipeline, which delivers crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field, was installed. Based on a review of the data in the COE permit application (No. 20-020-1632), the emplacement of the pipeline caused zero (0) impacts to marshes (emergent wetlands) and beaches. This is because the operator used horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the pipeline route maximized an open-water route to the extent possible. A comparison of aerial photos taken before and after Hurricanes Katrina and Rita reveal no observable landloss or impacts associated with the Endymion Oil Pipeline. Impacts to wetlands from pipeline emplacement associated with a CPA proposed action are expected to be low and could be further reduced through mitigation. However, in areas where oiling of wetlands occurred from the DWH event, there is the potential for disturbing oiled sediment and vegetation. It is possible that any dredging or trenching associated with pipeline placement could result in the disturbance of oiled sediment in Federal waters. A recent OSAT report (2010) found that there was no evidence of toxic components of oil (such as PAH's or dispersant chemicals) in the sediments that exceeded USEPA aquatic life benchmarks in sediments (in either offshore or coastal waters). Therefore, the potential one pipeline landfall estimated for a CPA proposed action would not be expected to resuspend contaminants in these areas.

Dredging

Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts except in areas that have been previously contaminated. However, a CPA proposed action is expected to only contribute minimally to the need for this dredging. As described below, less than 10 percent of traffic using navigation channels in the GOM is related to the OCS Program (**Tables 3-4 and 3-14**). Thus, vessel traffic related to a CPA proposed action is only a small portion of the traffic that would require maintenance dredging of channels. Alternative dredged material disposal methods can be used to enhance and create coastal wetlands after material has been tested for the presence of oil toxicity. Vessel traffic associated with a CPA proposed action is expected to contribute minimally to the erosion and widening of navigation channels and canals. Secondary impacts to wetlands would be primarily from vessel traffic corridors and will continue to cause approximately 0.6 ha (1.5 ac) of landloss per year, regardless of a CPA proposed action.

The COE's New Orleans District annually removes approximately 46-53 million m^3 (60-70 million yd^3) of dredged material from 10 Federal navigational channels throughout coastal Louisiana. Approximately 12,000,000 million m^3 (16 million yd^3) or 26 percent of this material is used for coastal wetland restoration projects (Creef, official communication, 2011). As a result of the tremendous wetlands landloss in the Louisiana coastal region, the beneficial use of dredge spoils is expected to increase. Executive Order 11990 (1977) requires that, where appropriate, material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage. Given the COE's policy of beneficial use of dredge, increased emphasis has been placed on the use of dredged material for marsh creation. For a CPA proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Dredging and dredged-material disposal can be detrimental to coastal environments and associated fish and wildlife that use these areas for nursery grounds and protection. These impacts may include increased erosion rates, turbidity, and changes in salinity. Many of these impacts are reduced through the use of modern disposal practices. Maintenance dredging of navigation channels deposits material on existing disposal banks and areas. The current COE policy for dredged material placement associated with channel maintenance is to either utilize the dredged material for marsh creation or restoration in the adjacent open waters along the navigation canals or use alternate bank disposal to maintain the existing hydrological connections within the marsh (Creef, official communication, 2011). These dredge management practices are expected to remain in effect for the duration of a CPA proposed action, and drainage is expected to continue unchanged, except if there is some localized and minor exacerbation of existing problems. For example, some dredged material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging would also temporarily increase turbidity levels in the vicinities of the dredging and disposal of materials, which can impact emergent wetlands and submerged vegetation communities.

Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) a hydraulic cutterhead suction dredge transfers sediments via connecting pipelines or (2) a clamshell bucket dredge transfers sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to the dredged-material disposal site. Coarser sediment settles to the bottom where it spreads outward under the force of gravity, and finer sediments may remain in suspension longer. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area. The dredged sediments are released into the area specified for disposal. This method usually produces positive topographic relief in the placement area, although the effects may often be temporary. Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged materials (Rozas, 1992). Placement of this material alongside canals converts low-lying marsh to upland, an environment unavailable to aquatic organisms except during extreme high tides. Dredged material can also form a barrier, causing ponding behind levees and limiting circulation between canal waters and marshes to infrequent, high-water events (Swenson and Turner, 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Turner and Cahoon, 1987; Rozas, 1992; Turner et al., 1994; Kuhn et al., 1999).

As a result of the DWH event, dredging may result in the resuspension and transport of oiled sediments in areas where oiling is known to have occurred. Findings of the OSAT report (OSAT, 2010) indicate that sediment and water toxicity associated with remnant oil in these coastal areas is minimal and does not exceed USEPA benchmarks for aquatic life. Three types of oil residue (supratidal buried oil, small surface residue balls, and submerged oil mats) were examined and evaluated in a report prepared by the Operational Science Advisory Team Report (OSAT-2, 2011) and submitted to the Gulf Coast Incident Management Team. Their findings indicated that the oil residues were well weathered and showed 86-98 percent depletion of total PAH. The PAH is one of the more toxic components of oil and can weaken marsh sediment by eliminating interstitial fauna. In addition, the marsh plants uptake these toxins from the soils where they are now available to the portion of the food chain that utilizes marsh plants in their diets. They also noted that, due to the effects of weathering, biodegradation, and location of the buried oil, there would be a minimal risk of leaching from supratidal buried oil. Based on modeling information, PAH concentration of buried oil in most locations will decrease by 20 percent within 5 years. In some isolated conditions, the PAH's could persist longer (OSAT-2, 2011). As such, BOEM believes that maintenance dredging operations that may be related to vessel traffic from a CPA proposed action would result in negligible impacts to wetland habitat due to the extensive weathering of oil residues in the dredged sediments.

Navigation Channels and Vessel Traffic

Vessel traffic that may support a CPA proposed action is discussed in **Chapter 3.1.1.8.4**. Most navigation channels projected to be used to support a CPA proposed action are shallow and are currently used by vessels that support the OCS Program (**Table 3-14**). Approximately 3,200 km (1,988 mi) of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf. This is exclusive of channels through large bays, sounds, and lagoons. About 2,000 km (1,243 mi) support OCS-related activities in the CPA. No new navigation channels are expected as a result of a CPA proposed action. Deepwater activities are anticipated to increase, requiring use of larger service vessels for efficient operations. This may put a substantial emphasis on shore bases associated with deeper channels. Ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand their infrastructure to accommodate deeper-draft vessels. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. At present, the entrance to Port Fourchon (Belle Pass Channel) is maintained at 9 m (29 ft). The inland channel in the port is 8 m (26 ft) and Bayou Lafourche is maintained at 7 m (24 ft). The FEMA has funded the dredging of several sites that were silted by Hurricanes Katrina and Rita.

Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion processes. Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Louisiana coast. According to Johnson and Gosselink (1982), canal widening rates in coastal Louisiana range from about 2.58 m/yr (8.46 ft/yr) for canals with the greatest boat activity to 0.95 m/yr (3.12 ft/yr) for canals with minimal boat activity. This study found navigational use is responsible for an average of 1.5 m/yr (4.9 ft/yr) of the canal widening. About 2,000 km (1,243 mi) of navigation channels support OCS-related activities in the CPA. Total navigational use results in about 300 ha (741 ac) of landloss per year. A USGS study by Johnston et al. (2009) found that canal widening rates have slowed rather than increased in recent years as a result of increased bank stabilization efforts. Thus, the canal widening rates established by Johnson and Gosselink (1982) are considered overestimates. The most heavily-used OCS navigation channel is the channel from Port Fourchon which is heavily armored and is less erodible. A recent BOEM and USGS-funded study (Thatcher et al., 2011) examined the susceptibility to erosion of navigation channels based on cover and substrate. During the study, the shorelines along both banks of navigation canals were mapped using aerial photography from 1978 to 1979, 1996 to 1997, and 2005 to 2006. To measure shoreline changes, transects were generated. The erosion rates were quantified to determine whether differences in erosion rates are related to embankment substrate, vegetation type, geologic region, or soil type. The study found erosion rates were variable within and across unarmored portions of the navigation channels. Previous studies have found that canal erosion rates have slowed in recent years, and the results of this study support that conclusion. The rate of change differed significantly by geologic region and marsh vegetation type. However, when rates for all canals were combined for each time period, the average canal widening rate slowed to -0.99 m/yr (-3.25 ft/yr) for the 1996/1998-2005/2006 time period compared with -1.71 m/yr (-5.61 ft/yr) for the earlier 1978/1979-1996/1998 time period. Therefore, this indicates there is a decrease in the rate of erosion for the area during that time period.

Disposal of OCS-Related Wastes

Produced sands, oil-based or synthetic-based drilling muds and cuttings; along with fluids from well treatment, workover, and completion activities would be transported to shore for disposal. Sufficient disposal capacity is assumed to be available in support of a CPA proposed action (**Chapter 3.1.2.2**). Discharging OCS-related produced water into inshore waters has been discontinued, so all OCS-produced waters are discharged into offshore Gulf waters in accordance with NPDES permits or transported to shore for injection. Produced waters are not expected to affect coastal wetlands. Because of wetland-protection regulations, no new waste disposal site would be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation.

Onshore Facilities

Various kinds of onshore facilities service OCS development. All projected new facilities that are attributed to the OCS Program and a CPA proposed action are described in **Chapter 3.1.2**. State and Federal permitting agencies discourage the placement of new facilities and the expansion of existing facilities in wetlands. Any impacts upon wetlands are mitigated in accordance with Clean Water Act requirements and the COE's 404 permit and State permitting programs.

Overview of Existing Mitigation Techniques and Results

Numerous mitigation methods have been recommended and used in the field to reduce or avoid adverse impacts to wetlands. Depending on the location, project, and surrounding environment, different mitigation techniques may be more appropriate than others. Based on permits, work documents, and interviews, 17 mitigation techniques have been implemented at least once with regards to the OCS. Because no one technique or suite of techniques are routinely required by permitting agencies, each pipeline mitigation process is uniquely designed to minimize damages given the particular setting and equipment to be installed. Of the identified mitigation techniques, there are a number of techniques that are commonly required. Some other mitigation techniques are rarely used because they are considered obsolete or because they are applicable only to a narrow range of settings. **Table 4-3** summarizes the recommended mitigating techniques to reduce or avoid adverse impact to wetlands from pipeline construction, canals, dredging, and dredged material placement. These mitigation methods are those most commonly applied by the permitting agencies (COE and the State in which the activity has occurred or would occur). These methods may include selective placement of the pipelines in existing rights-of-way, directional drilling to route under rather than through wetlands, push-pull pipe installation, and new restoration and revegetation methods. The BOEM is not a permitting agency for onshore pipelines, canals, dredging, and dredged material placement.

Proposed Action Analysis

Zero to one pipeline landfalls that could result in up to 2 km (1.2 mi) of onshore pipeline are projected as a result of a CPA proposed action. Should one be constructed, it would most likely be in Louisiana, where the large majority of infrastructure exists for receiving oil and gas from the CPA. Pipeline landfall may occur through or in the immediate vicinity of coastal wetlands and marshes. Wherever a landfall occurs, permitting/mitigating processes are in place to ensure wetland habitats are protected first through avoidance, then minimization of impacts, and finally compensation for unavoidable impacts to wetlands. The use of modern technologies, such as directional boring, greatly reduces and possibly eliminates most impacts to coastal wetlands and marshes. About 5-8 ha (12-20 ac) of landloss for the projected 2 km (1.2 mi) of pipeline (based on historic loss rates) are expected from a CPA proposed action. This represents approximately 0.25 percent of the total landloss estimated to occur along the Louisiana coast in 1 year (~2,590 ha or 10 mi^2) (Barras et al., 2003). This estimate does not take into account the present regulatory programs of COE and the Louisiana Dept. of Natural Resources, modern installation techniques, and “no net loss” policy that would result in zero to negligible impacts to wetland habitats. Therefore, effects on coastal wetlands and marshes from new pipeline laying activities associated with a CPA proposed action are expected to be minor or nonexistent. For a CPA proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

A CPA proposed action is estimated to contribute 2-3 percent of the total OCS traffic from 2012 through 2051 (**Tables 3-3 and 3-4**). Further details concerning vessel traffic can be found in **Chapter 3.1.1.8.4**. Navigation channels projected to be used in support of a CPA proposed action are discussed in **Chapter 3.1.2.1.8**. All estimated navigational use is expected to contribute approximately 1.5 m/yr (4.9 ft/yr) to the widening to the roughly 2,000 km (1,243 mi) of unarmored navigation channels used by OCS Program-related vessels, or about 300 ha/yr (741 ac/yr) of landloss per year (Johnson and Gosselink, 1982). An evaluation of landloss rates suggests that landloss related to navigation channel usage had been relatively stable from the 1970’s through 2004 (Barras et al., 2008). Barras et al. (2008) states that, during 1985-2004, the majority of the coastal landloss occurred on the Deltaic Plain at a rate of 3,885-4,144 ha/yr (15-16 mi^2/yr). The results of a recently completed study that included both armored and unarmored canals supports the hypothesis that there are reduced loss rates along armored canals (Johnston et al., 2009; Thatcher et al., 2011) and that widening rates have slowed based on maintenance techniques. The relatively small percentage of vessel traffic, in combination with armoring and regular maintenance along the waterways, should minimize the impacts related to the vessel traffic from a CPA proposed action.

Summary and Conclusion

It is expected that impacts would be reduced or eliminated through mitigation, such as horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive wetland habitats. Although maintenance dredging of navigation channels and canals in the CPA is expected to occur, a CPA proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create wetlands. Secondary impacts to wetlands from a CPA proposed action would result from OCS-related vessel traffic contributing to the erosion and widening of navigation channels and canals. This would cause approximately 1 ha (3 ac) of landloss per year. Overall, the impacts to wetlands from routine activities associated with a CPA proposed action are expected to be low due to the small length of projected onshore pipelines, the minimal contribution to the need for maintenance dredging, and the mitigation measures that would be used to further reduce these impacts.

4.2.1.4.3. Impacts of Accidental Events

Background/Introduction

A detailed description of the wetlands resource and the impact-producing factors and scenario for accidental events from a CPA proposed action are given in **Chapters 4.2.1.4.1 and 3.2**. There is also a risk analysis of accidental events in **Chapter 3.2.1.4**. The main impact-producing factors that would affect wetlands are oil spills.

With the reduced protection of the barrier islands lost due to hurricanes and anthropogenic factors, there is a greater potential for the oiling of coastal wetlands during an accidental event. Both coastal and offshore oil spills can be caused by large tropical cyclone events such as Hurricanes Katrina, Rita, Gustav, and Ike.

Areas of the Louisiana coast have been further stressed through shoreline oiling associated with the DWH event. While extensive areas of the Louisiana coastline received some degree of oiling, the most heavily oiled areas were around the Mississippi River Birdsfoot Delta, Pass a Loutre, and the Barataria Bay Estuary (Bayou Jimmy) due to their close proximity to the spill. Mississippi, Alabama, and eastern Florida also received varying amounts of oil from the DWH event, but generally less than the Louisiana coast. In most cases, offshore spills, unless catastrophic in nature (e.g., DWH event spill), are not expected to significantly damage any wetlands along the Gulf Coast. See **Appendix B** for an analysis of impacts from a low-probability catastrophic spill event.

It must be noted that, even with offshore spills, the degree of coastal impact is a function of the source oil type (e.g., Macondo involved a light crude oil), volume, and condition of the oil as it reaches shore, along with the season of the spill and the composition of the wetland plant community affected.

Primary Impacts of Oil Spills

While there are concerns that offshore spills may contribute to wetland damage, the distance of these production facilities from the wetland makes the probability of toxic oil reaching coastal wetlands low. With the DWH event, which was a catastrophic spill, the OSAT report (2010) noted that contamination for both toxic hydrocarbon components (including PAH's and alkanes) and dispersant-related chemicals were limited to within an approximate 3-km (~2-km) radius of the wellhead. There were no USEPA exceedances for aquatic wildlife in either sediments or water samples beyond the 3 km (~2 mi) distance from the DWH wellhead in the affected areas sampled (OSAT, 2010). The toxicity of the spilled oil from offshore is greatly reduced or eliminated by weathering, wave action, and dispersants.

The greatest threat to wetland habitat with regard to an oil spill is from an inland spill resulting from a vessel accident or pipeline rupture. These spills are a concern since they would be much closer to the wetland resource. While a resulting slick may cause some impacts to wetland habitat, the cleanup effort (i.e., equipment, chemicals, and personnel) can generate greater effects to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. Added concerns or factors that influence the effect of an oil spill to wetlands are the fate (frequency and weathering) and behavior of oil, air pollution, availability and adequacy of containment and cleanup technologies, and impacts of various oil-spill cleanup methods.

Numerous investigators have studied the immediate impacts of oil spills on Gulf wetland habitats, as well as wetland habitats elsewhere. Often, seemingly contradictory conclusions are generated from these impact assessments. These contradictions can be explained by differences in parameters, including oil concentrations and chemical composition, vegetation type and density, season or weather, preexisting stress level on the vegetation, soil types, and water levels. Data suggest that vegetation that is lightly oiled will experience plant die-back, followed by recovery without replanting; therefore, most impacts to vegetation are considered to be short term and reversible (Lytle, 1975; DeLaune et al., 1979; Webb et al., 1985; Alexander and Webb, 1987; Fischel et al., 1989).

Shoreline types have been rated via the ESI and, depending on a shoreline's expected retention of oil and some biological effects of oil, different shorelines could exhibit varying levels of oil persistence (Hayes et al., 1980; Irvine, 2000). Oil has been found or estimated to persist for at least 17-20 years in low-energy environments like salt marshes (Teal et al., 1992; Baker et al., 1993; Burns et al., 1993; Irvine, 2000). In some instances, where there has been further damage due to cleanup activities, recovery has been estimated to take from 8 to 100 years (Baca et al., 1987). Effects on marsh vegetation can be severe (Baca et al., 1987; Baker et al., 1993). The long-term recovery times occurred in nutrient-limited, colder environments where biodegradation is limited. But, those conditions are unlike the nutrient-rich marshes of the Gulf Coast. An effect from the depletion of marsh vegetation is increased erosion, which is of special concern to coastal Louisiana and parts of coastal Texas. Cleanup activities in marshes that can last years to decades following a spill may accelerate erosion rates and retard recovery rates.

The critical concentration of oil is the concentration above which impacts to wetlands would be long term because recovery would take longer than two growing seasons and which causes plant mortality and permanent wetland loss. In coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be 0.1 L/m^2 (0.026 gal/10.76 ft^2). Concentrations less than this typically cause dieback of the above ground vegetation for one growing season, but limited mortality. Higher concentrations would cause mortality of contacted vegetation, but 35 percent of the affected area would recover within 4 years. Oil can persist in the wetland soil for at least 5 years depending on the types of soil nitrogen and oxygen availability. After 10 years, permanent loss of 10 percent of the affected wetland area can be expected from accelerated landloss indirectly caused by a spill. If a spill contacts wetlands exposed to wave action, additional and accelerated erosion could occur (Alexander and Webb, 1987). Louisiana wetlands are assumed to be more sensitive to oil contact than elsewhere in the Gulf because of high cumulative stress.

A current study associated with the DWH event notes that there is evidence of recovery within 1 year after the spill, with shoot production in heavily oiled areas along the Louisiana coast (Delaune and Wright, 2011). This recovery held true in heavily oiled areas where the stems and leaves of the marsh vegetation was oiled, although depending on vegetation type, the amount of recovery varied (Delaune and Wright, 2011; Kokaly et al., 2011). Kokaly et al. (2011) noted oiling and, to some degree, rate of recovery in their comparative study of oiling in the Mississippi Birdsfoot Delta and Bay Jimmy in Barataria Bay. They examined species and the height of marsh vegetation, as well as, water level fluctuation, marsh damage, and amount of recovery. In the Birdsfoot Delta the predominant marsh grass is tall and less susceptible to being completely oiled; thus, damage is minimized. However, Bay Jimmy is dominated by *Spartina alterniflora* and *Juncus roemerianus* marsh grasses and both are short in height and susceptible to being fully oiled depending on tidal conditions. While inshore penetration of oil was farther inland at Bay Jimmy than the Birdsfoot Delta site, the study found indicators of further degradation and recovery at both sites after 1 year with little to no remediation (Kokaly et al., 2011). Some areas showed great reductions in live vegetation and evidence of sediment erosion. While in other areas at these sites, damaged zones had signs of growth and recovery, with the regrowth of vegetation identified in up to 10 percent of the areas assessed (Kokaly et al., 2011).

The OCS-related pipelines traverse wetland areas; pipeline accidents could result in high concentrations of oil directly contacting localized areas of wetland habitats (Fischel et al., 1989). The fluid nature of the oil, water levels, weather, and the density of the vegetation would limit the area of interior wetlands contacted by any given spill. Other studies have noted that oil is more persistent in anoxic sediments and, as a result of this longer residence time, has the potential to do damage to both marsh vegetation and associated benthic species. The sediment type, the anoxic condition of the soils, and whether the area is in a low- or high-energy environment all play a part in the persistence of oil in marsh sediment (Teal and Howarth, 1984). Based on data from Mendelssohn et al. (1990), recovered vegetation is expected to be the ecologically functional equivalent of unaffected vegetation. This study tested the reduction in plant density as the principle impact from spills. Mendelssohn and his associates demonstrated that oil could persist in the soil for greater than 5 years if a pipeline spill occurs within the interior of a wetland where wave-induced or tidal flushing is not regular or vigorous (Mendelssohn et al., 1990). Since most of the wetlands along the northern Gulf Coast are in moderate- to high-energy environments, sediment transport and tidal stirring should reduce the chances for oil persisting in the event that these areas are oiled.

While oil can completely foul wetland plants, it is the amount and type of oil as well as the particular plant that determines recovery. Some studies (Pezeshki et al., 2000) found that the Louisiana crude was less damaging and fatal to *S. alterniflora* marsh grass than the heavier crudes. Heavy oiling can stop photosynthetic activity, but the *S. alterniflora* produced additional leaves and was able to recover without shoreline cleanup. The experiment did note that *S. alterniflora* benefited and recovered more quickly after shoreline cleanup. Observations by Dr. White (official communication, 2010) noted the same type of recovery with *Spartina* spp. in the Mississippi River Birdsfoot Delta after the marshes were oiled from the DWH event. Within several weeks of the oiling, there was production of new shoots and no indication of root damage. He attributes the success partly to no invasive cleanup procedures in the marsh, which could result in the compaction of the soils and cause oil to get into the root systems. These findings were further documented by Kokaly et al. (2011) in the comparative study of the Birdsfoot Delta and Bay Jimmy discussed in the previous paragraph. Although the Louisiana Coast is more stressed as a result of oil development and hurricanes, it has a viable wetland fringe that is located in a well-flushed tidal environment.

Secondary Impacts of Oil Spills

The short-term effects of oil on wetland plants range from reduction in transpiration and carbon fixation to plant mortality. Depending on the type and quantity of oil in the sediment, mineralization of nutrients can be blocked so there is less nutrient uptake from the soils. The potential impact of the oiling on the wetland habitats is dependent on several factors, including season, wetland (fresh, salt, or brackish), sediment type, oil type, and quantity and degree of oiling. In general, most wetland plants are more susceptible to impacts from oiling during the growing season. Heavy oil causes mortality by coating gas exchange surfaces on the plants and by sealing sediment, which limits nutrient exchange to below-ground tissue. Light weight oils have been found to be more toxic to different marsh plants and associated organisms because the oil alters membrane permeability and disrupts metabolism (Pezeshki et al., 2000). Due to the difference in oil tolerances of various wetland plants, changes in species composition may be evident as a secondary impact of the spill (Pezeshki et al., 2000). Studies indicated that some dominant freshwater marsh species (*Sagittaria lancifolia*) are tolerant to oil fouling and that some may recover without being cleaned (Lin and Mendelssohn, 1996). Even though some species recover from fouling without being cleaned and others benefit from cleaning (Pezeshki et al., 2000), other studies by Mendelssohn et al. (1990 and 1993) noted that the plant composition in an oiled marsh can be changed post-spill as a result of plant sensitivity to oil. So, there can be a trade off from the disturbance within these wetlands resulting from workers gaining access to the plants by foot or boat and the potential benefits of cleaning. The compaction of the soil, in combination with the oiling, may further stress the plants and result in greater mortality (Pezeshki et al., 1995).

In a study by Mendelssohn et al. (1993) of a coastal pipeline break, low dosages of Louisiana crude (0.3 m^2 or 3 ft^2 marsh coverage) resulted in considerable short-term effects on the brackish marsh community. These effects were due to wind and high water conditions. Winds increased water levels in the marsh and resulted in a more complete oiling of both stems and leaves, which caused a 64 percent decrease in adjacent vegetation live cover. While considerable die out of the marsh was noted, recovery of the marsh was complete within 5 years despite the residual hydrocarbons that were found in the marsh sediment (Mendelssohn et al., 1993). As noted in other studies and Mendelssohn et al. (1993), the season and wind direction at the time of a spill can increase the potential impact to wetlands. The study also noted that the health of the recolonizing vegetation was not significantly different from the health of vegetation found in the areas that were not oiled. Patterns of landloss were spatially variable but the rate of loss was no different than the unaffected areas. It appears that in areas of incomplete recovery, the low soil elevation, coupled with subsidence, made them more susceptible to frequent flooding prior to the spill. In addition, the soil elevations were further compacted and elevation was lowered by the heavy machinery used in the cleanup operations (Mendelssohn et al., 1993).

As noted earlier, cleanup of these sensitive wetland habitats can be more disruptive and sometimes damaging than the oiling incident itself. Following the DWH event, USEPA and the USCG National Incident Command held a technology workshop and established an Interagency Alternative Technology Assessment Program (IATAP). This IATAP included numerous Federal agencies and local marsh ecologists with expertise concerning oil-spill cleanup to determine the least damaging approach to oil cleanup in these fragile coastal environments (USDHS, CG, 2010c). The IATAP group reviewed various methods of response that could be used in areas that, based on hydrologic modeling, would receive oil. Current methods to clean up oil spills include mechanical and chemical removal, in-situ burning, and bioremediation. The IATAP work group reviewed these and other mitigating measures specifically for areas where the vegetation had already been oiled. The IATAP recommended to keep the oil offshore and out of the marshes as long as possible, to not use actions that would further drive oil into the sediment (e.g., vessel and foot traffic), to not burn oil-contaminated vegetation if the water depth is insufficient or if there is the potential for re-oiling (this may result in root damage), to not apply dispersants in the marsh, to not use high-pressure washing that could drive oil deeper in sediments, to not hand clean vegetation (utilize low-pressure flushing if possible), and to monitor the utilization of sorbent booms. Bioremediation recommendations from the group were to minimize or eliminate vessel and foot traffic; mechanical removal methods should not disturb the substrate. Consideration was given to using nutrients and bacteria or fungi to enhance biodegradation. However, since the Gulf Coast is not nutrient limited, it was not determined to be useful. Two crucial points made by IATAP workgroup were (1) the use of particular cleanup methods is situation-dependent and (2) in the case of marshes it was best to do nothing and let nature take its course. The weathered oils measured in the sediments and reported in the OSAT report (2010) did not surpass any EPA exceedances for aquatic wildlife benchmarks, and the National Environmental Benefits Analysis performed by the OSAT determined that the residual oil remaining after cleanup efforts would be less damaging to the habitat and the resources using them than continuing the cleanup effort.

The cleanup of oil spills in coastal marshes remains a problematic issue because wetlands can be extremely sensitive to the disturbances associated with cleanup activities. Once a marsh is impacted by an oil spill, a decision must be made concerning the best method of cleanup and restoration. Often the best course of action is to let the impacted area(s) recover naturally in order to avoid secondary impacts associated with the cleanup process, such as trampling vegetation, accelerating erosion, and burying oil (McCauley and Harrel, 1981; Long and Vandermeulen, 1983: Getter et al., 1984; Baker et al., 1993; Mendelssohn et al., 1993). A study (Nyman and Patrick, 1996) involving three types of cleaning methods (fertilization, dispersant, and chemical) on freshwater marshes indicated that oil was removed from the plant or site, no long-term enhancement resulted from utilizing any of these response methods.

Proposed Action Analysis

Wetlands are generally more susceptible to contact by inshore spills, which have a low probability of occurrence from OCS-related activities. Inshore vessel collisions may release fuel and lubricant oils, and pipeline ruptures may release crude and condensate oil. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related, commercial and recreational activities remain the same. Therefore, the coastal waters of Louisiana, Mississippi, and Alabama would have a total of 200, 30, and 10 spills <1,000 bbl/yr, respectively, from all sources. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Mississippi, and Alabama would have a total of 130-170, 3-5, and about 2 spills <1,000 bbl/yr, respectively. Louisiana is the state most likely to have a spill ≥1,000 bbl occur in coastal waters.

Activity that would result from the addition of a CPA proposed action would cause a negligible increase in the risk of a large spill occurring and contacting wetlands. If oil should reach the wetlands from this distance, it would likely be weathered through biodegradation, mixing, etc. The probabilities of an offshore spill ≥1,000 bbl occurring and contacting environmental features are described in **Chapter 3.2.1.5.7**. In addition, the results of a risk analysis estimating the likelihood of a spill <1,000 bbl occurring and contacting environmental resources (including wetlands) can be found in **Chapters 3.2.1.6.6 and 3.2.1.7.2**. Eight parishes in Louisiana have a chance of a spill ≥1,000 bbl occurring and contacting their shores. For these parishes, the probability of an OCS offshore spill ≥1,000 bbl ranges from <0.5 to 8 percent. Generally, the coastal, deltaic parishes of Louisiana have the highest risk of being contacted by an offshore spill from a CPA proposed action. Plaquemines Parish, Louisiana, has the highest probability at 3-8 percent (**Figure 3-10**). For offshore spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. A few (5-11) offshore spills of 50-1,000 bbl are estimated to occur as a result of a CPA proposed action, and a few of these slicks are expected to occur proximate to State waters and to reach shore (**Table 3-12**). Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Sensitive coastal environments in eastern Louisiana from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. Should a spill contact a wetland, oiling is expected to be light.

The potential impacts of a catastrophic spill such as the DWH event are discussed in **Appendix B** to the extent possible with the current data available. However, the probability of a catastrophic spill such as the DWH event is low. If a catastrophic spill such as the DWH event should occur, the extent of the oiling may vary depending on sea conditions, dispersant use, and response time and methods. As seen with the DWH event, physical alterations to hydrological conditions through berm construction may result in changes to coastal landscapes. (See **Chapter 3.3.3.2**, "OCS Sand Borrowing," regarding berms constructed in Louisiana as part of the DWH response.). The end result of island modification as a result of changed hydrologic conditions due to berm construction will only be known through the results of long-term monitoring.

Summary and Conclusion

Offshore oil spills resulting from a CPA proposed action would have a low probability of contacting and damaging any wetlands along the Gulf Coast, except in the case of a catastrophic event (**Appendix B**). This is because of the distance of the spill to the coast, the likely weathered condition of oil (through evaporation, dilution, and biodegradation) should it reach the coast, and because wetlands are generally protected by barrier islands, peninsulas, sand spits, and currents. Although the probability of occurrence is low, the greatest threat from an oil spill to wetland habitat is from an inland spill as a result of a nearshore vessel accident or pipeline rupture. Wetlands in the northern Gulf of Mexico are in moderate- to high-energy environments; therefore, sediment transport and tidal stirring should reduce the chances for oil persisting in the event that these areas are oiled. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment, chemical treatments, and personnel used to clean up can generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. In addition, an assessment of the area covered, oil type, and plant composition of the wetland oiled should be made prior to choosing remediation treatment. These treatments could include mechanical and chemical techniques with onsite technicians. Overall, impacts to wetland habitats from an oil spill associated with activities related to a CPA proposed action would be expected to be low and temporary because of the nature of the system, regulations, and specific cleanup techniques.

4.2.1.4.4. Cumulative Impacts

Background/Introduction

The main factors that cumulatively affect wetlands are dredging, navigation channels and canals, pipelines, oil spills, flood control modifications, and development of wetlands. The contribution of the OCS Program and proposed action activities to these cumulative impacts remains small. The following is a summary of these effects on the wetlands and how a CPA proposed action would not add significant negative effects to wetlands.

Dredging of Channels

Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed of in existing disposal areas. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. Depending upon the regions and the soils through which they were dredged, secondary adverse impacts of canals may be more locally significant than direct impacts. Additional wetland losses may be generated by the secondary impacts of saltwater intrusion, flank subsidence, freshwater-reservoir reduction, and deeper tidal penetration. A variety of mitigation efforts have been initiated to protect against direct and indirect wetland loss. The nonmaintenance of mitigation structures that reduce canal construction impacts can have substantial impacts upon wetlands. These localized impacts are expected to continue. Various estimates of the total, relative direct, and indirect impacts of pipeline and navigation canals on wetland loss vary enormously; they range from estimates of 9 percent (Britsch and Dunbar 1993) to 33 percent (Penland et al., 2001a and 2001b) to estimates of >50 percent (Turner et al., 1982; Scaife et al., 1983; Bass and Turner, 1997). A panel review of scientific evidence suggests that wetland losses directly from human activities account for <12 percent of the total wetland loss experienced since 1930 and for approximately 29 percent of the total losses between 1955 and 1978 (Boesch et al., 1994). Of these direct losses, 33 percent are attributed to canal and spoil bank creation (10% of overall wetland loss). In Louisiana, deepening the Fourchon Channel to accommodate larger OCS-related service vessels has occurred within a saline marsh environment and provides the opportunity to create wetlands with the dredged materials. In addition, installation and improvement of channel armor along the Port Fourchon channel and the enforcement of vessel speed and "no wake zones" should greatly reduce the loss of wetlands due to erosion and vessel traffic.

There are 12 navigation channels (**Table 4-65**) used to service OCS activities in the CPA, 9 of which are shallow-water channels and 3 are deep-draft channels. All the channels will continue to require some form of maintenance dredging. The dredging cycle can range from 1 to 6 years, depending on channel or channel segment. Secondary wetland loss will continue throughout the 40-year project life because of canal widening resulting from erosion, saltwater intrusion, or a combination of the two. The extent of the losses depends on the future construction of channel stabilization features, hurricane activity, and increase in vessel use. The BOEM has used a widening rate for OCS Program-related channels of 1.5 m/yr (4.9 ft/yr). This number is likely an overestimate of losses since different erosion rates for armored channels are not considered. More recent studies by USGS found that canal widening rates have slowed rather than increased in recent years as a result of increased bank stabilization efforts (Johnston et al., 2009). The results of a recently completed study that included both armored and unarmored canals supports the hypothesis that there are reduced loss rates along armored canals (Thatcher et al., 2011). In the Thatcher et al. (2011) study, significant differences in shoreline retreat rates were noted depending on geology, marsh vegetation type, and, in some degree, the organic content of the soil. When evaluating a combination of all of the navigation canals in the study area, including those in the CPA, it was shown that erosion rates have slowed in recent years. The average current canal widening rate of -0.99 m/yr (-3.25 ft/yr) for the 1996/1998-2005/06 time period was reduced when compared with the -1.7 m/yr (-5.61 ft/year) for the earlier 1978/79-1996-1998 time period. Thatcher et al. (2011) further showed that the highest erosion rates were along portions of the navigation canals located in salt marshes in the Chenier Plain, which contained higher percentages of organic soil.

Depending upon the regions and soils through which they were dredged, secondary adverse impacts of canals may be more locally significant than direct impacts. The OCS activities are expected to result in some level of dredging activity associated with the expansion of offshore platforms or onshore transfer or production facilities if needed. The primary indirect impacts from dredging would be wetland loss as a result of saltwater intrusion or vessel-traffic erosion. However, the primary support, transfer, and production facilities used for a CPA proposed action are located along armored canals and waterways, thus minimizing marsh loss. In the foreseeable future, there will be a continuing need for dredged material for both coastal restoration, wetland creation and, to some extent, offshore sediments (e.g., sand, etc.) needed for beach restoration and hurricane protection. Alternative dredged-material disposal methods can be beneficially used for wetland creation or restoration as required by the COE permitting program.

It is also noted that the DWH event spill exposed both inland and offshore navigation channels to dispersant-treated oil. This exposure could result in submerged oil mats in certain areas of coastal waters; however, these submerged oil mats were found near shore and not necessarily in coastal navigation channels (OSAT, 2010). Further sampling associated with the OSAT and other studies concerning the DWH event reported no exceedances of the USEPA benchmarks for aquatic life, including total PAH, beyond 3 km (~2 mi) from the wellhead (OSAT, 2010; Atlas and Hazen, 2011). Therefore, even if submerged oil mats or residual oil were to be encountered during a CPA proposed action, impact would be minimal to none. Additional information on the condition of the oil resulting from the DWH event will be made publicly available as the NRDA assessment process progresses and analyses are completed. Dredging in these areas could resuspend remnant oiled sediments, but these sediments are not expected to be toxic. This is because of dispersant treatment, weathering, and natural biodegradation that will have already occurred.

Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals, maintenance, and usage of existing rig access canals and drill slips, and for preparation of new well sites. Locally, subsidence may be due to the extraction of large volumes of oil and gas from subsurface reservoirs, but subsidence associated with this factor seems to have slowed greatly over the last three decades as the reservoirs are depleted. However, recent reexamination of subsidence mechanisms by Stephens (2010b) states that the "Northern Gulf of Mexico continental margin is segmented by northwest-southeast trending transfer fault zones related to Mesozoic rifting." Indirect impacts from dredging new canals for State onshore oil and gas development (**Chapter 3.3.2**) and from the maintenance of the existing canal network are expected to continue. Maintenance dredging of the OCS-related navigation channels accounts for 10 percent of the dredged material produced.

A CPA proposed action is expected to use existing navigation channels and to contribute minimally to the need for additional channel maintenance. Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals, maintenance, and usage of existing rig access canals and drill slips, and preparation of new well sites. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be placed in existing disposal areas or alternate bank disposal techniques would be used. The alternate bank disposal technique creates gaps to maintain hydrological connections and tidal circulation important in maintaining a functioning wetland.

Navigation Channels and Canals and Coastal Infrastructure

The effects of pipelines and canal dredging on navigation activities and wetlands are described in **Chapter 4.2.1.4.2**. As noted in the referenced chapter above, the previous OCS activities associated with the CPA are expected to require some level of dredging, channel deepening, and maintenance of access canals. Onshore activity that would further accelerate wetland loss includes additional construction of access channels to shoreline staging areas and expansion or construction of onshore and offshore facilities (production platforms or receiving and transfer facilities). Management activities, including erosion protection and restoration along the edges of these canals, can significantly reduce canal-widening impacts on wetland loss (Johnston et al., 2009; Thatcher et al., 2011). These studies noted that activities related to navigation canals can be mitigated with bank stabilization, enforcement of no wake zones, and where possible, the beneficial use of dredged material (produced during maintenance dredging activities) to create wetland or upland habitats. A CPA proposed action is estimated to contribute 2-3 percent of the total OCS traffic from 2012 through 2051 (**Tables 3-3 and 3-4**). Therefore, marsh loss resulting from the combination of vessel-induced erosion and saltwater intrusion from navigation channels and canals is unlikely.

Pipelines

Modern pipeline installation methods such as the "push–pull" installation, where no trenching or dredging is necessary, cause little wetland loss. Directional drilling is also used for pipeline placement and allows the pipe to be placed under the wetland or beach without disturbing the wetlands on the surface above. While impacts are greatly reduced by mitigation techniques, expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment transport, and habitat conversion can still occur (Cox et al., 1997; Morton, 2003; Ko and Day, 2004a). The majority (over 80%) of OCS Program-related direct landloss is estimated to be from pipelines (Turner and Cahoon, 1987). Since the beginning of OCS Program activities in the GOM, approximately 15,400 km (9,563 mi) of pipelines have been constructed in Louisiana. These are seaward of the inland CZM boundary to the 3-mi (5-km) State/Federal boundary offshore. Of those pipelines, about 8,000 km (4,971 mi) cross wetland and upland habitat. The remaining 7,400 km (4,595 mi) cross waterbodies (Johnston et al., 2009). The total length of non-OCS Program-related pipelines through wetlands is believed to be approximately twice that of the Gulf OCS Program, or about 15,285 km (9,492 mi). There is a total of approximately 23,285 km (14,460 mi) of pipelines through Louisiana coastal wetlands. The majority of OCS pipelines entering State waters tie into existing pipeline systems and do not result in new landfalls. Pipeline maintenance activities that disturb wetlands are very infrequent and are mitigated to the maximum extent practicable. However, there is expected to only be 0-1 new pipeline landfalls related to a CPA proposed action.

The widening of OCS Program-related pipeline canals does not appear to be an important factor contributing to OCS-related direct landloss. This is because few pipelines are open to navigation, and the impact width does not appear to be significantly different from that for open pipelines closed to navigation. Based on the projected coastal Louisiana wetlands loss of 132,607 ha (327,679 ac) for the years 2000-2040 (Barras et al., 2003), landloss resulting from new OCS Program pipeline construction represents <1 percent of the total expected wetlands loss for that time period. This estimate does not take into account the present regulatory programs and modern installation techniques. Recently built pipelines and pipeline canals are much narrower than in the past because of advances in technology and improved methods of installation. These advances are due to a greater awareness among regulatory agencies and industry (Johnston et al., 2009). The magnitude of impacts from OCS Program-related pipelines is inversely proportional to the quantity and quality of mitigation techniques applied. Pipelines with extensive mitigation measures appeared to have minimal impacts, while pipelines without such measures contributed to significant habit changes. Through proper construction methods, mitigation and maintenance, impacts can be minimized or altogether avoided. The BOEM is not a permitting agency for onshore pipelines. The permitting agency would be COE and the State in which the activity occur(ed). Therefore, it would be the responsibility of COE and the States to ensure that wetland impacts resulting from pipeline construction are properly mitigated and monitored.

Oil Spills

The potential for coastal/inland oil spills will continue, regardless of the source. This creates the greatest concern for coastal wetlands, depending on the spill's proximity to these vegetated areas. The potential for vessel contact with improperly marked and abandoned wells in State nearshore waters will continue to increase until adequate funding is provided to monitor and inspect wells for compliance with procedures and regulations governing abandoned wells. Aging infrastructure, including both OCS Program and State oil and gas platforms and pipelines, will continue to be a potential source of both inland and offshore spills. Over 3,000 production platforms in the Gulf are over 20 years old and were constructed prior to the modern structural requirements that increase endurance to hurricane force winds (Casselman, 2010). Earlier studies (Pulsipher et al., 1998) found that the age of a platform significantly affects the risk of an oil-spill accident during the exploration and production operations. Older pipelines are more susceptible to leaks through corrosion. As a result of how the older pipelines are constructed, these pipelines cannot be monitored or periodically inspected for potential leaks or pipeline weakness with modern, automated, high-tech pipe inspection and monitoring techniques; therefore, the potential for preventing a potential leak is small. The potential for onshore and nearshore spills may decrease as a result of more stringent regulations and new policies that call for increased enforcement to address properly plugging and dismantling abandoned wells.

Offshore spills are less likely to reach the coastal wetlands in a fully toxic condition due to weathering and the blockage of spills by barrier islands. However, any reduced elevation and erosion of these barrier islands by Hurricanes Katrina and Rita decreased the level of protection afforded the mainland (USDOC, NMFS, 2007a). Flood tides may now bring some oil through tidal inlets into areas landward of barrier beaches. The turbulence of tidal water passing through most tidal passes would break up the slick, thereby accelerating dispersion and weathering. For the majority of these situations, light oiling of vegetated wetlands may occur. Any adverse impacts that may occur to wetland plants are expected to be very short lived, probably less than 1 year. The OCS Program-related spills could occur as a result of pipeline accidents and barge or shuttle tanker accidents during transit or offloading. The frequency, size, distribution, and impacts of OCS Program-related coastal spills are provided in **Chapter 3.2.1.7**. Non-OCS Program-related spills can occur in coastal regions as a result of import tankers, coastal oil production activities, and petroleum product transfer accidents. Their distribution is believed to be similar to that described in **Chapter 3.1.1.8**.

The oil stresses the wetland communities, making them more susceptible to saltwater intrusion, drought, disease, and other stressors (Ko and Day, 2004a). Spills that occur in or near Chandeleur or Mississippi Sounds could affect wetland habitat in or near the Gulf Islands National Seashore and the Breton National Wildlife Refuge and Wilderness Area. Because of their natural history, these areas are considered areas of special importance. They also support endangered and threatened species. Although the wetland acreage on these islands is small, the wetlands make up an important element in the habitat of the islands. The inlets that connect Mississippi Sound with the marsh-fringed estuaries and lagoons within the islands are narrow, so a small percentage of the oil that contacts the Sound side of the islands would be carried by the tides into interior lagoons. The past discharge of saltwater and drilling fluids associated with oil and gas development has been responsible for the decline or death of some local marshes (Morton, 2003). Discharging OCS-related produced water into inshore waters has been discontinued, and all OCS-produced waters transported to shore are either injected or disposed of in Gulf waters and would not affect coastal wetlands.

The numbers and sizes of coastal spills are presented in **Table 3-23**. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related, commercial and recreational activities remain the same. Therefore, the coastal waters of Louisiana, Mississippi, and Alabama would have a total of 200, 30, and 10 spills <1,000 bbl/yr, respectively, from all sources. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Mississippi, and Alabama would have a total of 130-170, 3-5, and about 2 spills <1,000 bbl/yr, respectively. Louisiana is the state most likely to have a spill ≥1,000 bbl occur in coastal waters.

In terms of offshore spills, up to one spill of ≥1,000 bbl is estimated to occur for a CPA proposed action over the 40-year time period (**Table 3-12**). The median spill size for this spill is estimated to be 2,200 bbl. The majority of offshore spills estimated for a CPA proposed action are smaller in size, with ~900-1,800 spills between 0 and 1 bbl in size estimated to occur for a CPA proposed action. **Chapter 3.2.1** describes projections of future spill events in more detail.

The DWH event was the largest spill recorded in the GOM and resulted in the oiling of an extensive portion of the northern Gulf Coast shoreline from east of the Texas/Louisiana State line to northwest Florida (Florida Panhandle) (OSAT-2, 2011). This event must be considered in the cumulative baseline due to the volume of oil released and the geographic area affected. However, unlike other historic large spills (*Exxon Valdez* and *Ixtoc*), the oil was released and treated in deep water nearly 77 km (48 mi) from shore, and the spill occurred in an unconfined open ocean as opposed to a sheltered embayment. All of these factors contribute to the weathering and detoxification of the oil that reached the shoreline. It is too early to determine the cumulative long-term effect, if any, of this spill and its contribution to the ongoing marsh loss or the acceleration of that loss. The current view of most wetland scientists in the area is that, due to the minimal penetration into the marsh, the weathered condition of the oil, and the observed resiliency of the marsh plants to oiling, the overall effect would be minor and recovery of some marsh vegetation is already being seen (Burdeau and Collins, 2010; Mascarelli, 2010; Zabarenko, 2010). In their review of available literature on oil impacts in Gulf Coast wetlands, DeLaune and Wright (2011) found that marsh vegetation, under most conditions, recovers naturally after exposure to oil without receiving enhanced oil cleanup treatments. The recovery rate depends on the amount of oiling, penetration of oil into the soil profile, and the sensitivity of a particular plant or the plant's vulnerability (height) to oil or the depth of oiling. While catastrophic spills could occur in the future as a result of human error, new regulations focusing on improved safety, more regulatory checks, and inspections should decrease the already small likelihood of the occurrence of such spills.

The BOEM acknowledges that there remains incomplete and unavailable information that may be relevant to reasonably foreseeable significant impacts on wetlands. This incomplete or unavailable information includes potential data on the DWH event that may be forthcoming. As there is substantial information available since the DWH event, which is included in this EIS, BOEM believes that the incomplete or unavailable information regarding effects of DWH on wetlands would likely not be essential to a reasoned choice among alternatives. The bulk of this information is expected to be developed through the ongoing NRDA process. To date, relatively little raw data have been released publicly by the NRDA process, and it may be years before studies are completed and results are released. This information will certainly not be available within the timeframe contemplated by this NEPA analysis. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. The BOEM subject-matter experts have used what scientifically credible information is available in their analyses, and applied it using accepted scientific methodology. Compared with the historic and ongoing threats to wetlands, such as development threats, natural factors such as hurricanes, and channelization, any remaining effects of the DWH event on wetlands are expected to be small.

Periodic Wetlands Loss

It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 26 km^2/yr (10 mi^2/yr) over the next 50 years. This would be expected to result in an additional net loss of 1,326 km^2 (512 mi^2) by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al., 2003). However, in 2005, Hurricanes Katrina and Rita caused 562 km^2 (217 mi^2) of land change (primarily wetlands to open water) (Barras, 2006). Based on the analysis of the latest satellite imagery, approximately 212 km^2 (82 mi^2) of additional open-water habitat was in areas primarily impacted by Hurricane Katrina (e.g., Mississippi River Delta Basin, Breton Sound Basin, Pontchartrain Basin, and Pearl River Basin) (Barras, 2007b and 2009). Also, 256 km^2 (99 mi^2) of open-water habitat was in areas primarily impacted by Hurricane Rita (e.g., Calcasieu/Sabine Basin, Mermentau Basin, Teche/Vermilion Basin, Atchafalaya Basin, and Terrebonne Basin). Barataria Basin contained approximately 46.6 km^2 (18 mi^2) of new open-water habitat caused by both hurricanes. These new open-water habitats represent landloss caused by the direct removal of wetlands. They may also indicate transitory changes of wetlands to open water caused by remnant flooding, removal of aquatic vegetation, scouring of marsh vegetation, and water-level variation attributed to normal tidal and meteorological variation between satellite images. An accurate evaluation of permanent loss of wetland areas is difficult until several growing seasons have been evaluated. The presence of strong tropical storms is a routine background condition in the Gulf that must be taken into consideration. Coastal change from storms in the area included both beach erosion and the erosion of channels where water continues to flow seaward to the Gulf of Mexico (Doran et al., 2009). These eroded barriers that once protected the wetlands behind them were severely eroded by the storms. The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and have shifted the coastal area from a condition of net land building to one of net landloss, and these effects are discussed in **Chapter 4.1.1.4.4** (see also U.S. Dept. of the Army, COE, 2004a).

Development in Wetlands

The development of wetlands for agricultural, residential, and commercial uses will continue with more regulatory and planning constraints. Impacts from residential, commercial, and agricultural and silvicultural (forest expansion) developments are expected to continue in coastal regions around the Gulf. Existing regulations and development permitting procedures indicate that development-related wetland loss may be slowed. Wetland damage would be minimized through the implementation of CZM guidelines, COE regulatory guidelines for wetland development, and various State and Federal coastal development programs. Examples of these programs are the Coastal Impact Assistance Program (CIAP), the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), and LACPR.

The past discharge of saltwater and drilling fluids associated with oil and gas development has been responsible for the decline or death of some marshes (Morton, 2003). Discharging OCS-related produced water into inshore waters has been discontinued, and all OCS-produced waters transported to shore would either be injected or disposed of in offshore Gulf waters and would not affect coastal wetlands (**Chapter 3.1.2.2**). Dredged material would be deposited either in existing approved discharge sites or would be used beneficially for wetland restoration or creation. In the Port Fourchon area, some of the existing areas being filled with dredged material may be used, if needed, for the expansion of oil production or support facilities.

Cumulative loss of wetlands has occurred as a result of both natural and anthropogenic events. Natural subsidence has caused wetland loss through compaction of Holocene strata (the rocks and deposits from 10,000 years ago to present). Human factors such as onshore oil and gas extraction, groundwater extraction, drainage of wetland soils, and burdens placed by building roads and levees have also caused wetland loss. Areas of local subsidence have also been correlated to the past extraction of large volumes of underground resources including oil, gas, water, sulfur, and salt (Morton, 2003; Morton et al., 2002 and 2005). There is increasing new evidence of the importance of the effect of sea-level rise (or marsh subsidence) as it relates to the loss of or changes in marshes, types of marsh, and plant diversity (Spalding and Hester, 2007). This 2007 study shows that the very structure of coastal wetlands would likely be altered by sea-level rise because community shifts would be governed by the responses of individual species to new environmental conditions. As noted previously, Stephens (2010b) has identified faulting mechanisms in coastal Louisiana that actually may be causing what appears to be subsidence. Flood control and channel training along the Mississippi River would continue to deprive the delta of the needed sediment required for the creation or maintenance of the existing wetlands. Another recent development that is presently being proposed along the Mississippi coast and is planned for the Louisiana and Texas coasts is the preparation of salt domes for the storage of strategic oil reserves. The current plan would result in discharging highly concentrated salt solutions into the nearshore Gulf and bays. The potential for large modifications (increases) in coastal salinities could result in devastating or severely compromising the coastal marshes (*The Mississippi Press*, 2007).

Following Hurricanes Katrina and Rita, the demand for large quantities of earthen construction materials for hurricane-protection levee construction or restoration resulted in either removing or damaging some marginal wetlands that could be highly productive. These wetland damages are required to be mitigated through the COE regulatory process, which means wetland functions are restored preferably either on the impacted site or at a secondary location. It is expected that the need for these materials will continue in the future.

Summary and Conclusion

Wetlands are most vulnerable to inshore or nearshore oil spills but these tend to be localized events. Spill sources include vessel collisions, pipeline breaks, and shore-based transfer, refining, and production facilities. The wetlands associated with a CPA proposed action have a minimal probability for oil-spill contact. This reduced risk is due to the distance of the offshore facility to wetland sites, beach and barrier island topography (although locally reduced post-Hurricanes Katrina and Rita), and product transportation through existing pipelines or pipeline corridors. Wetlands can also be at risk for offshore spills, but the risks are minimized by distance, time, sea conditions, weather conditions, and the implementation of a timely and appropriate spill-response effort.

If spills do reach shore, only light localized impacts to inland wetlands would occur. The wetland areas affected by the DWH event, with the possible exception of extremely heavily oiled areas (Bay Jimmy), have already shown signs of recovery through new shoot production and plant growth (White, official communication, 2010). In the heavily oiled areas (Bay Jimmy), it is still too early to determine the amount of recovery until sampling and analysis have been completed for an entire growing season. Initial sampling and analysis in both offshore and nearshore areas affected by the DWH event have been completed by NOAA and OSAT. These preliminary analyses support that the offshore spills become weathered and are reduced in toxicity in most cases. Three types of oil residue (supratidal buried oil, small surface residue balls, and submerged oil mats) were examined and evaluated in a report prepared by OSAT-2 (2011) and submitted to the Gulf Coast Incident Management Team. Their findings indicated that the oil residues were well weathered and showed a 86- to 98-percent depletion of total PAH's. The OSAT report also noted that, due to the effects of weathering, biodegradation, and the location of the buried oil, there would be a minimal risk of leaching from supratidal buried oil. Based on modeling information, PAH concentration of supratidal buried oil in most locations will decrease by 20 percent within 5 years. In some isolated conditions, the PAH's could persist longer (OSAT-2, 2011). If any inland spills occur, they would likely be small and at inland service bases or other support facilities and generally located away from wetlands; therefore, the spills would not be expected to affect wetlands.

While landloss will continue from subsidence and saltwater intrusion, the State of Louisiana and COE have implemented freshwater diversion projects to minimize the effect of this saltwater-induced landloss. Landloss would continue from vessel traffic; however, because of the small increase in traffic caused by a CPA proposed action, this loss would also be minimal. A CPA proposed action would not require any channel maintenance; therefore, no additional wetland loss would result from dredged material disposal. If dredged-material disposal is required, it would likely be beneficially used for marsh creation. The OCS wastes and drilling by-products would be delivered to existing disposal facilities approved by USEPA for handling these materials. Because of existing capacity, no additional expansion into wetland areas is expected.

Development pressures in the coastal regions of Louisiana, Mississippi, Alabama, and Florida have caused the destruction of large areas of wetlands. In coastal Louisiana, the most destructive developments have been the inland oil and gas industry projects, which have resulted in the dredging of huge numbers of access channels. Agricultural, residential, and commercial developments have caused the most destruction of wetlands in Mississippi, Alabama, and Florida. In Florida, recreational and tourist developments have been particularly destructive. These trends are expected to continue. During the period from 2001 to 2040, between 248,830 and 346,590 ha (614,872 and 856,443 ac) of wetlands would be lost from the Louisiana coastal zone and 1,600-2,000 ha (647-809 ac) would be lost from the Mississippi coastal zone. Wetland losses in the coastal zones of Alabama and Florida are assumed to be comparable with those in Mississippi. New and existing pipeline channels would continue eroding, largely at the expense of wetlands; however, channel armor may be added at a later date. However, these estimates do not take into account the current regulatory programs, modern construction techniques and mitigations, or any new techniques that might be developed in the future. Because of modern construction techniques and mitigation measures, there would be zero to negligible impacts on wetland habitats as a result of a pipeline emplacement. A CPA proposed action represents a small percentage (3-4%) of total OCS activity (USDOI, MMS, 2007c). Impacts associated with a CPA proposed action are a minimal part of the overall OCS impacts. The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and have shifted the coastal area from a condition of net land building to one of net landloss. Deltaic Louisiana is expected to continue to experience the greatest loss of wetland habitat. Wetland loss is also expected to continue in coastal

Mississippi, Alabama, and Florida, but at slower rates. The incremental contribution of a CPA proposed action to the cumulative impacts on coastal wetlands is expected to be small.

4.2.1.5. Seagrass Communities

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this EIS. This is a summary of the potential impacts. Turbidity impacts from pipeline installation and maintenance dredging associated with a CPA proposed action would be temporary and localized, and the impacts would be further reduced by permit requirements and mitigation. The increment of impacts from service-vessel transit associated with a CPA proposed action would be minimal because these vessels would continue to use the same channels that currently support the OCS Program and because these channels are generally away from submerged vegetation beds. Should an oil spill occur near a seagrass community, impacts from the spill and cleanup would be considered short term in duration and minor in scope. The floating nature of nondispersed crude oil, the regional microtidal range, the dynamic climate with mild temperatures, and the amount of microorganisms that consume oil would alleviate prolonged effects on submerged vegetation communities. Close monitoring and restrictions on the use of bottom-disturbing equipment to clean up the spill would be needed to avoid or minimize those impacts. Of the cumulative activities, dredging generates the greatest overall risk to submerged vegetation. However, hurricanes cause direct damage to seagrass beds, which could cause a failure to recover in the presence of cumulative stresses. When considered with other stresses, a CPA proposed action would cause a minor incremental contribution to cumulative impacts due to dredging from maintenance of channels.

4.2.1.5.1. Description of the Affected Environment

This is a description of seagrass communities in the CPA (Louisiana, Mississippi, Alabama, and because of its close proximity to the CPA, Florida is discussed here). This information is from a search that was conducted for information published on submerged vegetation, and various Internet sources were examined to determine any recent information regarding seagrasses. Sources investigated include BOEM, USDOC/NOAA, the USGS National Wetlands Research Center, the USGS Gulf of Mexico Integrated Science Data Information Management System, Seagrass Watch, Gulf of Mexico Alliance, State environmental agencies, USEPA, and coastal universities. Other websites from scientific publication databases were checked for new information using general Internet searches based on major themes.

Submerged vegetation distribution and composition depend on an interrelationship among a number of environmental factors that include water temperature, depth, turbidity, salinity, turbulence, and substrate suitability (Kemp, 1989; Onuf, 1996; Short et al., 2001). Marine seagrass beds generally occur in shallow, relatively clear, protected waters with sand bottoms (Short et al., 2001). Freshwater SAV species occur in the low-salinity waters of coastal estuaries (Castellanos and Rozas, 2001). True seagrasses that occur in the Gulf of Mexico are *Halodule beaudettei* (formerly *Halodule wrightii;* shoal grass), *Halophila decipiens* (paddle grass), *Halophila engelmannii* (star grass), *Syringodium filiforme* (manatee grass), and *Thalassia testudinum* (turtle grass) (Short et al., 2001; Handley et al., 2007). Although it is not considered a true seagrass because it has hydroanemophilous pollination (pollen grains float) and can tolerate freshwater, *Ruppia maritima* (widgeon grass) is common in the brackish waters of the Gulf of Mexico (Zieman, 1982; Berns, 2003; Cho and May, 2008). Freshwater genera that are dominant in the northern Gulf of Mexico are *Ceratophyllum*, *Najas*, *Potamogeton*, and *Vallisneria* (Castellanos and Rozas, 2001; Cho and May, 2008). Submerged vegetation increases protection from predation and food resources for associated nekton (Rozas and Odum, 1988; Maiaro, 2007). Seagrasses and freshwater SAV's provide important nursery and permanent habitat for sunfish, killifish, immature shrimp, crabs, drum, trout, flounder, and several other nekton species, and they provide a food source for species of wintering waterfowl and megaherbivores (Rozas and Odum, 1988; Rooker et al., 1998; Castellanos and Rozas, 2001; Heck et al., 2003; Orth et al., 2006). Nekton densities are often higher in SAV and seagrass habitats than in nonvegetated areas because of the protection and forging opportunities these habitats offer (Castellanos and Rozas, 2001; Sheridan and Minello, 2003; Hitch et al., 2011). They also act in carbon sequestration, nutrient cycling, and sediment stabilization (Heck et al., 2003; Duarte et al., 2005; Orth et al., 2006; Frankovich et al., 2011). They are also substrate for epiphytes to grow, and while this can be a hindrance (shading) to the seagrass if too thick, those epiphytes serve as another food source to different species (Howard and Short, 1986; Bologna and Heck, 1999).

According to the most recent and comprehensive data available, approximately 500,000 ha (1.25 million ac) of seagrass beds are estimated to exist in exposed, shallow coastal/nearshore waters and embayments of the Gulf of Mexico, and over 80 percent of these beds are in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). In the northern Gulf of Mexico from south Texas to Mobile Bay, seagrasses occur in relatively small beds behind barrier islands in bays, lagoons, and coastal waters (**Figure 4-4**), while SAV's occur in the upper freshwater regions of estuaries and rivers (Onuf, 1996; Castellanos and Rozas, 2001; Handley et al., 2007). Increased nutrients and sediments from either natural or anthropogenic events such as tropical cyclones and watershed runoff are common and significant causes of seagrass decline (Carlson and Madley, 2007). Recent increases in natural and anthropogenic stresses have led to decreases in these communities worldwide (Orth et al., 2006). The USGS's *Seagrass Status and Trend in the Northern Gulf of Mexico: 1940-2002* demonstrated a decrease of seagrass coverage across the northern Gulf of Mexico from the bays of Texas to the Gulf shores of Florida, and this loss was from approximately 1.02 million ha (2.52 million ac) estimated in 1992 to approximately 500,000 ha (1.25 million ac) calculated in the 2002 report (Handley et al., 2007). While declines have been documented for different species in different areas, it is difficult to estimate rates of decrease because of the fluctuation of biomass among the different species, seasonally and yearly.

Louisiana: In Louisiana, submerged vegetation primarily consists of freshwater and low-salinity vegetation (SAV), and these beds are found in coastal waterbodies like Lake Pontchartrain, Biloxi Marsh, and the Barataria-Terrebonne estuary (Maiaro, 2007; Poirrier et al., 2010). Seagrass beds in Louisiana have low densities and are rare. This is largely due to the turbid water conditions that are caused by the Mississippi and Atchafalaya Rivers. The exceptions are the beds in the vicinity of the Chandeleur Island chain located between Louisiana and Mississippi (Poirrier, 2007). Many submerged beds in Louisiana are continually affected by storm events of different severities throughout the year, which dictate recovery time because that is a function of the size of the disturbance (Fourqurean and Rutten, 2004). In the past 5 years, three tropical cyclones made landfall near the Louisiana coast. Hurricane Humberto (2007) and Tropical Storm Edouard (2008) hit near the Texas/Louisiana border, but Hurricane Gustav (2008) made landfall near Cocodrie, Louisiana (USDOC, NOAA, 2010d). These storms hit areas that have a small amount of submerged vegetation. Hurricane Ida (2009) skirted the Mississippi River Delta before making landfall as a weakened extratropical mass in Alabama, and this storm event did not have any documented long-term effect on local submerged grass communities with wind force (USDOC, NOAA, 2010d). Submerged vegetation is physically removed, buried, or exposed to drastic salinity shifts after severe storm events (Maiaro, 2007). The recovery times for beds depend on the size of the disturbance. Strong storm events not only remove seagrass and SAV beds but also change the nekton community structure (Maiaro, 2007). In Biloxi Marsh, southeast Louisiana, nekton communities at sites denuded of *R. maritima* by Hurricanes Cindy and Katrina resembled communities in sites that had no vegetation before the hurricanes (Maiaro, 2007). A general description of storm effects on submerged vegetation is in **Chapter 4.2.1.5.4**. The seagrasses behind the Chandeleur Island chain and SAV communities within Plaquemines and St. Bernard Parishes likely had contact with the oil from the DWH event because this area had oil on the shoreline (USDOC, NOAA, 2010o; OSAT-2, 2011). This area also had considerable physical stress from various prevention and cleanup efforts such as the berm (Louisiana Coastal Protection and Restoration Authority, 2010). Because of increased sediment load from the berm, there could be a decrease in submerged vegetation and a negative impact on the communities in the areas affected by the DWH event (Martinez et al., 2012). There are ongoing research projects that will document effects of the spill and associated activities on local communities. This research also includes a study on the environmental effects from the oil barrier berms built in portions of southeastern Louisiana. Just under a half of these structures were constructed near the Chandeleur Island seagrass beds. These submerged beds help support the geologic integrity of Louisiana's fragile barrier islands and the biological integrity of Louisiana's essential fauna (Poirrier, 2007).

Mississippi: Seagrass beds primarily occur in the Mississippi Sound and are in the proximity of the Grand Bay National Estuarine Research Reserve, Buccaneer State Park, and the Gulf Island National Seashore islands of Ship, Horn, Petit Bois, and Cat (Moncreiff, 2007). After local extinctions of *T. testudinum* and *S. filiforme* from Hurricane Camille and recent increases in freshwater outflow from nearby watersheds, there has been an increase in *R. maritima* and a persistence of *H. beaudettei*, making them the predominant submerged vegetation communities along the Mississippi coast (Cho and May, 2008; Cho et al., 2009; Barry A. Vittor and Associates, Inc., 2009). While submerged vegetation abundance decreased in 2005 after the passage of Hurricanes Cindy and Katrina, there was a documented increase in abundance in 2006 (Cho and May, 2008). Because *R. maritima* is known to be resilient to temporary disturbances, further studies confirmed a seasonal trend to percent cover changes in Mississippi Sound (Cho and May, 2008). This resiliency could be an important factor in ecosystem health when disturbances are experienced. Mississippi Sound had oil slicks from the DWH event, and some beds within that area had contact with both tarballs and oil (USDOC, NOAA, 2010o). With oil in the area of Mississippi Sound, there is the potential for at least short-term decreases in seagrass cover and an adverse effect on the associated community. There is a more detailed discussion of oil-spill effects on submerged vegetation in **Chapter 4.2.1.5.3**.

Alabama: Barry A. Vittor & Associates, Inc. (2009) reported approximately 2,100 ha (5,250 ac) of freshwater and marine submerged vegetation in Alabama coastal waters. These communities are dominated by *Myriophyllum spicatum*, *Najas quadalupensis*, and *Vallisneria americana* in freshwater to *R. maritima* and *H. beaudettei* in marine waters. They found there was a decrease in SAV cover in the southern portion of the study area in coastal Alabama from 2002 to 2009 by approximately 20 percent. Hurricanes Ivan and Katrina potentially influenced the local SAV communities with increased salinity, water turbidity, and scouring from storm surges (Barry A. Vittor & Associates, Inc., 2009). However, there was no large-scale impact on the distribution or ecological performance of Alabama's marine seagrass beds from either Hurricane Ivan or Katrina (Byron and Heck, 2006; Anton et al., 2009). In the past 5 years, three tropical cyclones made landfall near or on the Alabama coast. Tropical Storm Claudette and Hurricane Ida were in 2009, and both were in weakened states at landfall (USDOC, NOAA, 2010d). Oil and tarballs from the DWH event contacted the barrier islands in coastal Alabama and, as stated in the Mississippi paragraph above, oil was in Mississippi Sound (USDOC, NOAA, 2010r). Alabama's submerged vegetation beds are similar to the coastal beds in Mississippi.

Florida: There are an estimated 400,000 ha (1 million ac) of seagrasses in west Florida's nearshore coastal waters and Florida Bay (Carlson and Madley, 2007). Most of the seagrass coverage in Florida is in south Florida and the higher-salinity estuarine regions in the Florida Panhandle, between Pensacola and Alligator Harbor, and the Big Bend area (Dawes et al., 2004; Carlson and Madley, 2007; Carlson et al., 2010). All of the seagrass species that occur in the northern Gulf of Mexico are present in Florida's waters. Many of the SAV genera are found in Florida's inland estuaries, bays, lagoons, and coastal rivers (Kraemer et al., 1999; Lores et al., 2000; Hoyer et al., 2004). The Big Bend area has low wave energy due to the shallow and gently sloping nature of the sea bottom, and these beds extend into Federal waters (CSA and Martel Laboratories, Inc., 1985; Zieman and Zieman, 1989). This area had declined by approximately 95,000 ha (234,750 ac) in 2001 to approximately 91,000 ha (224,866 ac) in 2006 (4.5%) in continuous seagrass coverage (Carlson et al., 2010). Throughout the west Florida shelf, there are seasonally patchy offshore beds of *H. decipiens* (Dawes et al., 2004). Many beds in Florida are protected by extensive barrier islands. These islands help protect the Florida coast from the many tropical cyclones that impact this State. However, the increased turbidity and freshwater from these storm events have decreased many areas of seagrass beds on the western coast of Florida (Carlson et al., 2010). In the past 5 years, Florida had six tropical cyclones make landfall on its western coast. These were Tropical Storm Alberto and Hurricane Ernesto in 2006, Tropical Storms Barry and Olga in 2007, Tropical Storm Fay in 2008, and Tropical Storm Claudette in 2009 (USDOC, NOAA, 2010d). These storms impacted different parts of the Florida coast from the panhandle to Tampa and the Keys. The panhandle was exposed to oil and tarballs from the DWH event, but the majority of the seagrass beds in south Florida received little impact from the DWH event (USDOC, NOAA, 2010o).

4.2.1.5.2. Impacts of Routine Events

Background/Introduction

The routine events associated with OCS activities in the CPA that could adversely affect submerged vegetation communities include construction of pipelines, canals, navigation channels, and onshore facilities; maintenance dredging; and vessel traffic (e.g., propeller scars). Many of these activities would result in an increase of water turbidity that is detrimental to submerged vegetation health. Through avoidance and mitigation policies, these effects are generally localized, short term, and minor in nature.

Existing and projected lengths of OCS-related dredging, pipelines, and vessel activities are described in detail in **Chapters 3.1.1 and 3.1.2**.

Proposed Action Analysis

Dredging impacts associated with the installation of new navigation channels, if any are needed, are greater than those for pipeline installations because they create a much wider and deeper footprint. A CPA proposed action, however, is only likely to result in 0-1 pipeline landfalls. Pipelines are heavily regulated and permitted, and they are likely to be required to be sited away from submerged vegetation. New canal dredging and related disposal of dredged material also cause significant changes in regional hydrology (Onuf, 1994; Collins, 1995; Erftemeijer and Lewis, 2006). Examples of channel impacts are the heavy vessel traffic utilizing the Gulf Intracoastal Waterway and the maintenance dredging of the waterway (Texas Parks and Wildlife Department, 1999). Deepwater oil and gas exploration requires larger vessels that could cause channel widening; however, the inshore facilities for these services would probably remain the same as they are now, and no new canals are expected to be required for a CPA proposed action. In Louisiana, some OCS service facilities are located in the parishes of Cameron, Calcasieu, Vermilion, Iberia, St. Mary, Terrebonne, Lafourche, Plaquemines, Jefferson, St. Bernard, and St. Charles (**Table 3-13**). In Mississippi, there is a shore base in Jackson County, and in Alabama the shore base is in Mobile County (**Table 3-13**). Channel dredging to facilitate, create, and maintain waterfront real estate, marinas, and waterways will continue to be a major impact-producing factor on the Gulf Coast. The waterway maintenance program of COE has been operating in the CPA for decades. Impacts generated by initial channel excavations are sustained by regular maintenance activities performed on average every 2-5 years. Maintenance activities are projected to continue into the future regardless of the OCS activities.

Dredge and fill activities are the greatest threats to submerged vegetation habitat (Wolfe et al., 1988). Effects from dredging and resuspension of sediments are relative to dredge type and sediment size (Collins, 1995). The most serious impacts generated by dredging activities to submerged vegetation and associated communities are a result of the removal of sediments, changes in salinity, burial of existing habitat, and oxygen depletion and reduced light associated with increased water turbidity (Erftemeijer and Lewis, 2006). Increased water turbidity from dredging operations that causes light attenuation negatively affects vegetation health (Onuf, 1994; Kenworthy and Fonseca, 1996). Suspension of the fine sediments from dredging activities may influence not only water clarity but also nutrient dynamics in estuaries, which can decrease overall primary production (Essink, 1999; Erftemeijer and Lewis, 2006). While the previously mentioned activities can decrease submerged vegetation cover, these actions would be localized and monitored events. Plans for the installation of new linear facilities and maintenance dredging are reviewed by a variety of Federal, State, and local agencies and the interested public in order to receive the necessary government approvals. Mitigation is generally required to reduce undesirable effects on submerged vegetation beds from dredging activities. The most effective mitigation for direct impacts to submerged vegetation beds and associated communities is avoidance; however, if contact is unavoidable then actions such as using turbidity curtains or silt dams with a sizable barrier can alleviate dredge effects. When possible, dredged material should be removed from the area during maintenance dredging to ensure total ecosystem recovery (Sheridan, 2004). These are examples of ways government and industries are decreasing unwanted impacts to submerged vegetation from dredging.

Pipeline construction in coastal waters could temporarily elevate water turbidity in submerged vegetation beds near the pipeline routes. The duration of increased water turbidity would depend on factors like currents, bottom topography, and substrate type (Collins, 1995). These effects would be similar to those discussed with dredging and increased turbidity. The COE and State permit requirements are expected to require pipeline routes that avoid high-salinity beds, as well as reduce and maintain water turbidity within tolerable limits for submerged vegetation. Currently 109 active OCS pipelines cross the Federal/State boundary into State waters and make landfall in Louisiana, 3 in Mississippi, and 4 in Alabama (**Table 3-13**). There are 0-1 new pipelines projected in State waters as a result of a proposed action of the OCS Program for the CPA. These activities are discussed in **Chapter 3.1.2.1.6**. Most activities would use existing inshore structures, so less than one pipeline a year would make landfall. If any new pipelines run to shore due to a CPA proposed action, environmental permit requirements for locating pipelines would result in minimal impact on seagrasses. Because of regular tidal flushing, increased water turbidity from pipeline activities is projected to be below significance levels. Therefore, effects on submerged vegetation by pipeline installation are predicted to be small and short term.

Vessel traffic would only pose a risk to seagrasses when near shore and to SAV when inshore. Submerged vegetation beds near active navigation channels would already be altered physically by regularly occurring associated activities. Because of the depths where major vessel traffic occurs, propeller wash would not resuspend sediments in navigation channels beyond pre-project conditions. Vessel traffic that would support a CPA proposed action would continue to use the same channels that currently support the OCS Program. Little, if any, damage to submerged vegetation beds would occur as a result of typical channel traffic. Scarring of seagrass beds by vessels (e.g., support vessels for OCS and State oil and gas activities, fishing vessels, and recreational watercraft) is an increasing concern along the Mississippi, Alabama, and Florida coasts (Sargent et al., 1995; USDOI, GS, 2004). Scarring most commonly occurs in water depths less than 2 m (~6 ft) as a result of boats operating in too shallow water (Zieman, 1976; Sargent et al., 1995; Dunton et al., 1998). Consequently, their propellers and occasionally their keels plow through vegetated bottoms tearing up roots, rhizomes, and whole plants, leaving a furrow that is devoid of submerged vegetation (Zieman, 1976; Dawes et al., 1997). This can ultimately destroy the beds, which are essential nursery habitat for many species (Heck et al., 2003; Orth et al., 2006). Scarring has been found to be higher in areas with heavy recreational boat use (South Florida Natural Resources Center, 2008). The recovery period from scarring increases with the width of the scar, type of scarring, sediment, water quality, and species (Zieman, 1976; Durako et al., 1992; Sargent et al., 1995). If a bed has extensive damage or an already stressed bed is damaged, it could take decades to recover. Scarring could have a more critical effect on habitat functions in areas with less submerged vegetation, like those found in Louisiana. The State of Florida has the Seagrass Outreach Partnership that consists of citizens, researchers, law enforcement officers, and marine resource managers. It was created to reduce boating impacts to seagrass meadows through education. Restoration efforts are funded through fines collected from boaters. There would be little reason for an OCS vessel to anchor or stop in areas that are not designated ports or work structures; therefore, it would be rare for these vessels to be in areas populated by vegetation.

Summary and Conclusion

Routine OCS activities in the CPA that may impact seagrasses are not expected to significantly increase in occurrence and range in the near future, with minimal associated nearshore activities and infrastructure, such as the projected one new pipeline landfall. Requirements of other Federal and State programs, such as avoidance of the seagrass and vegetation communities or the use of turbidity curtains, reduce the undesirable effects on submerged vegetation beds from dredging activities. Federal and State permit requirements should ensure pipeline routes avoid high-salinity beds and maintain water clarity and quality. Local programs decrease the occurrence of prop scarring in grass beds, and channels utilized by OCS vessels are generally away from exposed submerged vegetation beds. Because of these requirements and implemented programs, along with the beneficial effects of natural flushing (e.g., from winds and currents), any potential effects from routine activities on submerged vegetation in the CPA are expected to be localized and not significantly adverse.

As noted above in the affected environment section, there remains uncertainty regarding the impacts of the DWH event on submerged vegetation. At least for submerged vegetation in Louisiana, Mississippi, and Alabama, BOEM cannot definitively determine that the incomplete or unavailable information being developed through the NRDA process may be essential to a reasoned choice among alternatives. Nevertheless, the ongoing research on submerged vegetation after the DWH event is being conducted through the NRDA process. These research projects may be years from completion, and data and conclusions have not been released to the public. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Nevertheless, impacts to submerged vegetation from routine activities of a CPA proposed action are expected to be minimal due to the distance of most activities from the submerged vegetation beds, because the 0-1 pipeline landfall and maintenance dredging are heavily regulated and permitted, and because mitigations (such as turbidity curtains and siting away from beds) would likely be required.

4.2.1.5.3. Impacts of Accidental Events

Background/Introduction

In Louisiana, submerged vegetation primarily consists of freshwater and low-salinity vegetation, but there are seagrass beds in the vicinity of the Chandeleur Island chain (Poirrier, 2007). Mississippi seagrass beds primarily occur in Mississippi Sound and are in the proximity of the Gulf Island National Seashore islands (Moncreiff, 2007). Alabama's coast has submerged beds throughout the area. Most of the seagrass coverage in Florida is in south Florida and the higher-salinity estuarine regions in the Florida Panhandle, between Pensacola and Alligator Harbor, and the Big Bend area (Dawes et al., 2004; Carlson and Madley, 2007; Carlson et al., 2010). Accidental impact-producing factors from a CPA proposed action are discussed in **Chapter 3.2**.

Proposed Action Analysis

Accidental events possible with a CPA proposed action that could significantly adversely affect submerged vegetation beds include nearshore and inshore spills connected with the transport and storage of oil. Offshore oil spills that occur in the proposed action area are less likely to contact seagrass communities than are inshore spills because the seagrass beds are generally protected by barrier islands, peninsulas, sand spits, and currents. However, if the temporal and spatial duration of the spill is sufficiently large, then an offshore spill could affect submerged vegetation communities; these low-probability catastrophic spills are addressed in **Appendix B**.

The probabilities of a spill ≥1,000 bbl related to a CPA proposed action occurring and contacting environmental features are described in **Chapter 3.2.1.5.7**. The estimated number of offshore spill events over the 40-year life of a CPA proposed action is up to 1 spill for ≥1,000 bbl (**Table 3-12**). The risk of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was calculated by BOEM's oil-spill trajectory model. Counties and parishes are used as an indicator of the risk of an offshore spill reaching sensitive coastal environments, and this is the point when oil could contact a submerged vegetation community. **Figure 3-10** provides the results of the OSRA model that estimated the probability of a spill ≥1,000 bbl occurring offshore as the result of a CPA proposed action and contacting a Gulf Coast county or parish.

Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is <0.5 percent. Eight parishes in Louisiana and seven counties in Texas have a chance of spill contact that is >0.5 percent. For these counties/parishes, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline ranges from <0.5 percent to 8 percent (**Figure 3-10**). Plaquemines Parish, Louisiana has the greatest risk of a spill occurring and contacting its shoreline (8 percent). The Big Bend area of Florida, which can have seagrasses near Federal waters, has <0.5 percent chance of having contact from an oil spill in the OCS. Inshore spills may result from either vessel collisions or ruptured pipelines that release crude and condensate oil. The coast from the Atchafalaya Bay to east of the Mississippi River in Louisiana has the greatest risk of experiencing coastal spills related to a CPA proposed action (**Chapter 3.2.1.7.1**).

Because of the floating nature of nondispersed crude oil, the regional microtidal range, the dynamic climate with mild temperatures, oxidized sediment, and the amount of microorganisms that consume oil, these spills would typically be short-term events and have little prolonged effects on vegetated communities and the associated fauna (DeLaune et al., 1990; Taylor et al., 2007; Roth and Baltz, 2009). Increased water turbulence from waves, storms, or vessel traffic breaks apart the surface oil sheen and disperses some oil into the water column or mixes oil with sediments that could settle and coat an entire plant (Teal and Howarth, 1984; Burns et al., 1994). This coating situation also happens when oil is treated with dispersants because the dispersants break down the oil and it sinks into the water column (Thorhaug et al., 1986; Runcie et al., 2004). However, as reviewed in Runcie et al. (2004), oil mixed with dispersants has shown an array of effects on seagrass depending on the species and dispersant used. An offshore spill would inundate the coastal waters first and affect local communities similar to an inshore spill. With a greater distance from shore, there is a greater chance of the oil being weathered by natural and mechanical processes by the time it reaches the nearshore habitat.

If an oil slick settles into a protective embayment where submerged vegetation beds are located, decreased water clarity from coating and shading could cause reduced chlorophyll production and could lead to a decrease in vegetation (Erftemeijer and Lewis, 2006). Depending on the species and environmental factors (e.g., temperature and wave action), seagrasses may exhibit minimal impacts, such as localized loss of pigmentation, from a spill; however, communities residing within the beds could accrue greater negative outcomes (den Hartog and Jacobs, 1980; Jackson et al., 1989; Kenworthy et al., 1993; Taylor et al., 2006). Community effects could range from either direct mortality due to smothering or indirect mortality from loss of food sources and habitat to a decrease in ecological performance of the entire system depending on the severity and duration of the spill event (Zieman et al., 1984). Another source of potential impacts to submerged beds is the possibility of buried or sequestered oil becoming resuspended after a disturbance, which would have similar effects as the originally oiling event. Because different species have different levels of sensitivity to oil, it is difficult to compare studies and extrapolate what variables caused the documented differences in vegetation and community health (Thorhaug et al., 1986; Runcie et al., 2004). In general, studied seagrasses did not show significant negative effects from a spill (den Hartog and Jacobs, 1980; Kenworthy et al., 1993; Taylor et al., 2006; Taylor et al., 2007).

Prevention and cleanup efforts could also affect the health of submerged vegetation communities (Zieman et al., 1984). Many physical prevention methods such as booms, barrier berms, and diversions can alter hydrology, specifically changing salinity and water clarity. These changes would harm certain species of submerged vegetation because they are tolerant to certain salinities and light levels (Zieman et al., 1984; Kenworthy and Fonesca, 1996; Frazer et al., 2006). With cleanup, there is increased boat and human traffic in these sensitive areas that generally are protected from this degree of human disturbance prior to the response. Increased vessel traffic would lead to elevated water turbidity and increased prop scarring. While the elevated levels of water turbidity from vessels would be short-term and the possible damages from propellers could be longer, both events would be localized during the prevention and cleanup efforts (Zieman, 1976; Dawes et al., 1997). The information that is currently available since the DWH event about the current state of the submerged vegetation from Louisiana, Mississippi, Alabama, and Florida is found in **Chapter 4.2.1.5.1**.

Summary and Conclusion

Although the size is small and the duration short, the greatest threat to inland, submerged vegetation communities would be from an inland spill resulting from a vessel accident or pipeline rupture. The resulting slick may cause short-term and localized impacts to the submerged vegetation bed. There is also the remote possibility of an offshore spill to such an extent that it could also affect submerged vegetation beds, and this would have similar effects to an inshore spill. Because prevention and cleanup measures can have negative effects on submerged vegetation, close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. The floating nature of nondispersed crude oil, the regional microtidal range, the dynamic climate with mild temperatures, and the amount of microorganisms that consume oil would alleviate prolonged effects on submerged vegetation communities. Also, safety and spill-prevention technologies are expected to continue to improve and would decrease the detrimental effects to submerged vegetation from a CPA proposed action.

As noted above in the affected environment section, there remains uncertainty regarding the impacts of the DWH event on submerged vegetation. At least for submerged vegetation in Louisiana, Mississippi, and Alabama, BOEM cannot definitively determine that the incomplete or unavailable information being developed through the NRDA process may be essential to a reasoned choice among alternatives. Nevertheless, the ongoing research on submerged vegetation after the DWH event is being conducted through the NRDA process. These research projects may be years from completion, and data and conclusions have not been released to the public. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Nevertheless, impacts to submerged vegetation from an accidental event related to a CPA proposed action are expected to be minimal due to the distance of most activities from the submerged vegetation beds and because the likelihood of an accidental event of size, location, and duration reaching submerged vegetation spills remains small.

4.2.1.5.4. Cumulative Impacts

Of all of the activities in the cumulative scenario found in **Chapter 3.3,** dredging, oil spills/pipelines, hydrological changes, and storm events present the greatest threat of impacts to submerged vegetation communities.

Background/Introduction

Generally, dredging generates the greatest overall risk to submerged vegetation by uprooting and burying plants, decreasing oxygen in the water, and reducing water clarity in an area. Increased dredging in the CPA is expected only in areas that do not support submerged vegetation beds. Maintenance dredging would not have a substantial effect on existing seagrass habitat given that no new channels are expected to be dredged as a result of OCS activities in the CPA. Maintenance dredging and vessel traffic related to a CPA proposed action remains a subset of all dredging and traffic issues from all sources in the Gulf. Another anthropogenic activity that could cause adverse effects to submerged vegetation is accidental oil-spill events. These are generally rare and small-scale, but they do add to the possible cumulative damage to the submerged vegetation systems. Historic and some recent construction of structures like levees and berms change local hydrology and that effects submerged vegetation beds. There has also been an increase in tropical cyclone events in the Atlantic. Hurricanes generate substantial overall risk to submerged vegetation by burial and eroding channels through seagrass beds. When combined with other stresses, impacted seagrass beds may fail to recover.

In support of inshore petroleum development, the oil and gas industry performs dredging that impacts lower salinity submerged vegetation in Louisiana. Mitigation may be required to reduce undesirable impacts of dredging to submerged vegetation. Maintenance dredging of navigation channels by COE helps sustain the outcome of the original dredging event. This occurs generally every 2-5 years despite a CPA proposed action. For a proposed action in the CPA, offshore oil and gas activities are projected to generate 0-1 pipeline landfalls. The most effective mitigation for direct impacts to submerged vegetation beds is avoidance, but there are other mitigation techniques in place to lessen the effects of unavoidable disturbances. For a more detailed discussion of dredging effects on submerged vegetation, refer to **Chapter 4.2.1.5.2**.

Inshore oil spills generally present a greater risk of adversely impacting submerged vegetation and seagrass communities than do offshore spills with regards to OCS activities in the CPA. However, if an offshore spill is of large magnitude like that of the DWH event, then oil could make contact with and have similar effects to submerged vegetation beds as an inshore spill. Although little to no direct permanent mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude and refined oil has been implicated as a cause of the decline in plant biomass and cover, and as a cause of the observed changes in species composition within them (Zieman et al., 1984; Erftemeijer and Lewis, 2006). Because nondispersed oil floats and because of the local microtidal range, oil spills alone would typically have little impact on submerged vegetation beds and associated epifauna. During and after a spill event, the cleanup effort can cause significant scarring and trampling of submerged vegetation beds with increased traffic in the area. Preventative measures (booms, berms, and diversions) can alter water hydrology and salinity, which could harm the beds and their associated communities. With an 8 percent probability of an offshore oil spill making any possible contact with submerged vegetation beds (**Figure 3-10**) and because inshore spills would be small and short-lived, oil exposure is not expected to increase over current levels with a CPA proposed action. Oil-spill effects on submerged vegetation are discussed in more detail in **Chapter 4.2.1.5.3**.

Submerged vegetation communities can be scarred by boat anchors, keels, and propellers, and by activities such as trampling, trawling, and seismic surveys (Sargent et al., 1995; Dunton et al., 1998). Loggerhead turtles, other large animals, and storm events can scar vegetated bottoms. A few State and local governments (Seagrass Outreach Partnership) have instituted management programs that have resulted in reduced scarring, which could decrease bed patchiness. The OCS-related vessel traffic is not expected in areas of high submerged vegetation abundance. A more detailed discussion of vessel traffic effects on submerged vegetation can be found in **Chapter 4.2.1.5.2**.

Many of man's activities have caused landloss either directly or indirectly by accelerating natural processes. Floodwaters layered sediment over the active Mississippi River deltaic plain, and this accretion countered ongoing submergence and built new land. However, the river was channelized and leveed in the early 1900's. Because of this anthropogenic effect, areas that did not receive sediment-laden floodwaters continually lost elevation. Further compounding this effect, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction and soil conservation practices in the drainage basin (Turner and Cahoon, 1987).

Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (including submerged vegetation communities) (Boesch et al., 1994). Productivity and species diversity associated with SAV habitat in the coastal marshes of Louisiana are greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989; Lirman et al., 2008). Due to increased salinities farther up the estuaries, some salt-tolerant species of submerged vegetation (including seagrasses) are able to populate areas farther inland and outcompete the dominant SAV species (Longley, 1994). Large shifts in salinities can decrease both seagrass and SAV populations, which decreases their ecological function for juvenile fishes and invertebrates. An example of a salinity shift that occurs in Louisiana is the opening of the Bonnet Carré Spillway to divert the Mississippi River flood waters into Lake Pontchartrain during high-water stages. This freshwater eventually flows into Mississippi and Chandeleur Sounds, lowering salinities there. In the past, spillway openings have been associated with a noticeable decrease in seagrass vegetation acreage (Eleuterius, 1987). Conversely, the Caernarvon Freshwater Diversion into the Breton Sound Basin, east of the River, provides more regular flooding events, which have reduced average salinities there. Reduced salinities there have triggered a large increase in acreage of submerged aquatic vegetation like *R. maritima* (Cho et al., 2009).

When the Mississippi River is in flood condition, as in May 2011, floodways are opened to alleviate the threat of levee damage (e.g., Bonne Carré Spillway). The floodways of the Mississippi River direct water to estuarine areas where flood waters may suddenly reduce salinities for a couple of weeks to several months. This lower salinity can damage or kill high-salinity seagrass beds if low salinities are sustained for longer periods than the seagrass species can tolerate (Eleuterius, 1987). If this continues to happen, over time seagrass beds could become stressed and more vulnerable to other impacts. Increased nutrients from diversions, runoffs, or flooding events can cause eutrophication in local waters. This can increase phytoplankton and epiphytic growth, which will shade and decrease submerged vegetation (Borowitzka et al., 2006; Orth et al., 2006). This relationship is complex and depends on multiple environmental factors. A CPA proposed action is not going to significantly change flow regimes or add to eutrophication in the CPA.

Currently, there is a period of significant increased tropical cyclone activity in the Gulf of Mexico. These storms can remove or bury submerged beds and the barriers that protect them from storm surges. This could weaken the existing populations of local submerged vegetation. A list of recent storm events in the CPA is presented in **Chapter 4.2.1.5.1**. Seagrass beds have been repeatedly damaged by the natural processes of transgression from hurricane overwash of barrier islands. Storm-generated waves wash sand from the seaward side of the islands over the narrow islands and cut new passes through the islands. The overwashed sand buries seagrass beds on the back side of the islands. Cuts formed in the islands erode channels that remove seagrass in its path (Michot and Wells, 2005). Over time, seagrass recolonizes the new sand flats on the shoreward side, and the natural processes of sand movement rebuild the islands. Hurricane impacts can produce changes in seagrass community quality and composition (Maiaro, 2007). These increased tropical cyclone events coincide with the current period of global climate change. Whether it is from anthropogenic activities or natural cycles, increased surface water temperature, sea level, and storm events have effects on seagrass beds by adding stress to this sensitive and already stressed ecosystem (Orth et al., 2006). A CPA proposed action is not expected to significantly increase the effects from a natural disturbance.

Summary and Conclusion

In general, a CPA proposed action would cause a minor incremental contribution to impacts on submerged vegetation from dredging, pipeline installations, possibly oil spills, and boat scarring. Dredging generates the greatest overall risk to submerged vegetation, while naturally occurring hurricanes cause direct damage to beds. The implementation of proposed lease stipulations and mitigation policies currently in place, the small probability of an oil spill, and that flow regimes are expected to change, further reduces the incremental contribution of stress from a CPA proposed action to submerged vegetation.

Unavailable information on the effects to submerged vegetation from the DWH event (and thus changes to the submerged vegetation baseline in the affected environment) makes an understanding of the cumulative effects less clear. The BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to submerged vegetation. Relevant data on the status of submerged vegetation beds after the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches. Nevertheless, BOEM believes that incomplete or unavailable information regarding effects of DWH on submerged vegetation is not essential to a reasoned choice among alternatives in the cumulative effects analysis. In light of this, the incremental contribution of a CPA proposed action remains minor compared with the cumulative effects of other factors, including dredging, hurricanes, and vessel traffic.

4.2.1.6. Live Bottoms

4.2.1.6.1. Live Bottoms (Pinnacle Trend)

The BOEM has protected Pinnacle Trend features that support sensitive benthic communities since 1974 and recommends oil and gas operators avoid contact with these features by providing a 100-ft (30-m) buffer zone as described in NTL 2009-G39, "Biologically-Sensitive Underwater Features and Areas" (USDOI, MMS, 2009a). The Gulf of Mexico seafloor in the CPA is mostly mud bottoms with varying mixtures of sand in some areas; however, there are some rock features that protrude into the water column that form a reef that may support organisms that are different from those on typical soft bottoms. These reefs are relatively rare on the seafloor compared with the ubiquitous soft bottoms, and they provide habitat for sensitive species (Parker et al., 1983).

Pinnacle features are located on 74 OCS lease blocks in the northeastern CPA of the Gulf of Mexico. They are defined in this Agency's NTL 2009-G39, "Biologically-Sensitive Underwater Features and Areas," as "small, isolated, low to moderate relief carbonate reefal features or outcrops of unknown origin or hard substrates exposed by erosion that provide surface area for the growth of sessile invertebrates and attract large numbers of fish."

Over time, knowledge of these communities has increased and protective measures have evolved. This Agency has conducted environmental studies in the GOM for the past 35 years. Protective measures were instituted based on the nature and sensitivity of Pinnacle habitats and their associated communities. These protections have developed into stipulations applied to OCS leases. The lease stipulations establish protection zones around the core of the feature and prohibit any contact with the seafloor. Details of the restrictions are described in this Agency's NTL 2009-G39. The Biological Stipulation Map Package (http://boem.gov/Regulations/Notices-To-Lessees/Notices-to-Lessees-and-Operators.aspx) includes maps and lists of the protected features.

The BOEM has examined the Pinnacle Trend features based on the information presented below. Results of searches that were conducted for available data indicating any impacts to Pinnacle Trend features as a result of the DWH event have also been included in this assessment. A full analysis of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a CPA proposed action are presented in this document.

4.2.1.6.1.1. Description of the Affected Environment

The northeastern portion of the CPA exhibits a region of high topographic relief known as the "Pinnacle Trend" at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon. The Pinnacle Trend spreads over a 103 x 26 km area (64 x 16 mi) in water depths of 60-200 m (200-650 ft) (**Figure 4-36**). It includes pinnacles, flat-top reefs, patch reefs, reef-like mounds, and isobath parallel ridges (Sager et al., 1992; Brooks and Giammona, 1990; CSA, 1992b).

The Pinnacle Trend features consist of both high-relief outcroppings at the edge of the Mississippi-Alabama Shelf and low-relief hard bottoms on the inner and middle shelf. The high-relief features are complex in shape and structure and provide varied zones of microhabitat for attached organisms. Low-relief features include fields of small seafloor mounds that rise only a meter or two from the seafloor but provide hard surfaces for encrusting and attached epifauna. These low-relief, hard-bottom areas are discussed in **Chapter 4.2.1.6.2**. Both high- and low-relief features are relict features that developed prior to the most recent sea-level rise and do not support active reef-building activity (Thompson et al., 1999). Fields of shallow depressions about 1 to 5-6 m across (3-20 ft) also add complexity to the overall character of the Pinnacle Trend area.

The shape and configuration of these structures is similar to tropical coral reef formations. Early investigators of this area in 1957 hypothesized that they are "drowned calcareous reefs" (Ludwick and Walton, 1957). Drowned reefs are reefs that were shallow carbonate reefs long ago but their vertical growth has been outpaced by sea-level rise and seafloor subsidence, resulting in a skeletal reef structure in water too deep and dark to support a living coral reef (Schlager, 1981). More recent studies using dredges, grab samples, and imaging have confirmed this evaluation. Some of these formations are tall and steep-sided in profile. The taller mounds tend to have more complex shapes with pits and overhangs, in addition to flat tops and vertical sides (CSA and GERG, 2001).

The eastern part of the pinnacles area is covered with a thin, well-sorted layer of fine- to medium-grained quartzose sand from eastern continental rivers. The western portion is covered with fine silts, sands, and clays deposited by the Mississippi River (CSA, 1992b). The linear orientation and distribution of pinnacles correspond with depth contours and may represent a historic shoreline. The rocky pinnacles provide a surprising amount of surface area for the growth of sessile invertebrates and attract large numbers of fish.

This Agency has sponsored numerous studies providing information about these features (Brooks, 1991; CSA, 1992b; Thompson et al., 1999; CSA and GERG, 2001). A recent bathymetric survey by USGS has provided accurate, up-to-date imaging of the seafloor of the region (Gardner et al., 2002). The Pinnacle Trend covers 74 lease blocks in the CPA (**Figure 4-36)**, which is where BOEM has applied the Live Bottom (Pinnacle Trend) Stipulation to protect the ecosystem. This area includes portions of the continental shelf, shelf break, and upper continental slope. The outer limit of the continental shelf is delineated by the 75-m (246-ft) depth contour. **Figure 4-37** provides a perspective view of the central sector of the Mississippi-Alabama continental shelf. Descriptions of the features that are pictured in **Figure 4-37** are described below. The BOEM proposes the application of the Live Bottom (Pinnacle Trend) Stipulation for a CPA proposed action within any of the 74 OCS lease blocks that has Pinnacle Trend features.

Features of the Pinnacle Trend Area

Pinnacles

Tall spire-like mounds are the historical "pinnacles" for which the region is named. **Figure 4-38** shows a drawing of a pinnacle in the foreground. The pinnacles rise up to 20 m (66 ft) in height and can be over 500 m (1,640 ft) in diameter (Thompson et al., 1999; Brooks, 1991). They are scattered along the 74- to 82-m (243- to 269-ft) depth range and also extend laterally for over 28 km (17 mi) at the 105- to 120-m (345- to 394-ft) depth band (Thompson et al., 1999; Schroeder, 2000). The sides are steep and provide surface area for biological growth (CSA, 1992b). Pinnacles may have formed from coral-algal assemblages during a rapid sea-level rise (Brooks, 1991).

Patch Reefs

Patch reefs are small mushroom-shaped features about 2-12 m (6-39 ft) in diameter and 3-4 m (10-13 ft) in height that occur in many areas. They are particularly abundant in fields of as many as 35-70 features per hectare (2.47 ac) along the 74- to 82-m (243- to 269-ft) depth contour in two separate fields on the western portion of the shelf (Brooks, 1991; Schroeder, 2000).

Flat-Top Reefs

Flat-top reefs (**Figure 4-37**) are large reef-like structures that occur along the same depth contour as patch reefs (74-82 m; 243-269 ft) and follow the shelf edge for a distance of over 70 km (43 mi) (Brooks, 1991). They are located in the west-central region of the Mississippi-Alabama shelf (Schroeder, 2000). The reefs range from 75 to 700 m (245 to 2,300 ft) in diameter and from 7 to 14 m (23 to 46 ft) in height. The structures have steep sides like the pinnacles, but are flat on top. The flat tops of these features are all at essentially the same depth of 66 m (216 ft), which was probably at the sea surface during their period of formation (Sager et al., 1992).

Reef-Like Mounds

Pinnacles and flat-top reefs fall into the category of reef-like mounds; however, these formations are also present elsewhere (Thompson et al., 1999). **Figure 4-37** shows examples of these features. Several clusters are found shoreward in 60-70 m (197-230 ft) of water. In the western part of the pinnacle area, two clusters of reef-like mounds are found at the 87- to 94-m (285- to 308-ft) depth range (**Figure 4-37**) (Brooks, 1991). The mounds are 4 m (13 ft) high and 10-70 m (33-230 ft) wide. These features are also present along the western rim of the De Soto Canyon at depths of 70-80 m (230-262 ft) (Schroeder, 2000).

Ridges and Scarps

Ridges and scarps (**Figure 4-39**) are the largest features in the area and are found between the 68- and 76-m (223- and 249-ft) depth range (Schroeder, 2000). Linear ridges paralleling the isobaths are reported in various depths (Brooks, 1991; Thompson et al., 1999). These ridges are typically about 20 m (66 ft) wide (up to 250 m [820 ft]) and over 1 km (0.6 mi) long. Some ridges are 15 km (9 mi) long (Schroeder, 2000). Most of the ridges are low relief, around 1 m (3 ft) in height. Brooks (1991) found a ridge with scarps up to 8 m (26 ft) high in depths around 60 m (197 ft). They often occur in groups of 6-8 ridges together. They appear to be calcareous biogenic features formed during periods of slow sea-level rise during the last deglaciation (Sager et al., 1992), possibly from lithified coastal dunes (Thompson et al., 1999).

Shallow Depressions

Shallow depressions are another type of low-relief feature common in the pinnacle area, particularly to the west of the large pinnacle features. These occur in large fields that do not follow depth contours. The formations are found in large clusters (up to 80 per km^2) (Sager et al., 1992). They are usually irregularly shaped with bumpy rims, 5-10 m (16-33 ft) across, and probably less than a meter in depth. It is thought that they are formed by the collapse of sediments following gas expulsion (Brooks, 1991).

Nepheloid Layer

A persistent nepheloid layer characterized by high turbidity was identified as a controlling factor for hard-bottom communities in the northwestern Gulf of Mexico (Rezak et al., 1990). The nepheloid layer is a heavy layer of turbid water laden with sediment that is carried along by water currents above the seafloor. This layer reduces the light reaching the reef, resulting in decreased epibiota and reef fish species richness and abundance below 80 m (262 ft) (Dennis and Bright, 1988; Rezak et al., 1990). Previous studies have suggested that the Mississippi River plume influences the distribution and abundance of sessile invertebrates within 70 km (43 mi) of the river delta and may produce a gradient of sedimentation and water-column turbidity throughout the Pinnacle Trend (Gittings et al., 1992b; CSA and GERG, 2001). In the northeastern Gulf, nepheloid layers are infrequent; although in conjunction with episodic Mississippi freshwater plumes and upwelling, they result in increased light attenuation (CSA and GERG, 2001).

Ecology of the Pinnacle Trend Area

The pinnacles provide a significant amount of hard substrate for colonization by suspension-feeding invertebrates and support relatively rich live-bottom and fish communities. Assemblages of coralline algae, sponges, octocorals, crinoids, bryozoans, and fishes are present at the tops of the shallowest features in water depths of less than 70 m (230 ft) (CSA, 1992b). On the deeper features, as well as along the sides of these shallower pinnacles, ahermatypic corals may be locally abundant, along with octocorals, crinoids, and basket stars. The diversity and abundance of the associated species appear to be related to the size and complexity of the features, with the low-relief rock outcrops (<1 m [3 ft] height) typically having low faunal densities, and higher relief features having the more diverse faunal communities (Gittings et al., 1992b; Thompson et al., 1999).

Environmental Influences on the Pinnacle Trend Area

Substrate characteristics and turbidity seem to be the major factors determining the composition of communities at different locations and depth levels in the Pinnacle Trend. The biological communities on the Pinnacle Trend become more diverse toward the east and with greater distance from the Mississippi River (Gittings et al., 1992b). This is a matter of both substrate and turbidity. The Mississippi River brings a large load of fine silty sediment to the Gulf of Mexico. Although the majority of this turbidity is swept to the west by currents, it does affect the communities to the east. Sometimes the pattern is reversed with the majority swept to the east. Previous studies have suggested that the Mississippi River plume influences the distribution and abundance of sessile invertebrates within 70 km (43 mi) of the river delta and may produce a gradient of sedimentation and water-column turbidity throughout the Pinnacle Trend (Gittings et al., 1992b; CSA and GERG, 2001).

In addition, a nepheloid layer (heavy bottom turbidity layer), common in the western Gulf of Mexico, sometimes affects the Pinnacle Trend (Weaver et al., 2002). Resuspension of sediments is a major contributor to turbidity in the Pinnacle Trend. This is more severe in the western part of the Pinnacle Trend area because currents and wave action resuspend the silty sediments deposited by the Mississippi River.

Because of the depth of the bottom (60-120 m; 200-400 ft) in the Pinnacle Trend area, waves seldom have a direct influence. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments. These forces are not expected to be strong enough to cause direct physical damage to organisms living on the reefs. Rather, currents are created by the wave action that can resuspend sediments to produce added turbidity and sedimentation (Brooks, 1991; CSA, 1992b). The animals in this region are well-adapted to the effects common to this frequently turbid environment. The end result of these factors is that benthic communities closer to the Mississippi River are less diverse (CSA, 1992b).

Diversity and density of epibenthic organisms varies considerably between features in the Pinnacle Trend area. The general trend is less turbidity and greater biological development toward the east. In addition, the sediment is less silty to the east. This results in an increase of diversity and density of organisms to the east. Other factors, such as areas with more exposed hard bottom, vertical relief, rugosity, and complexity of the substrate contribute to higher biological diversity and density.

The association of multiple features in proximity to one another makes an area more biologically diverse and promotes higher densities of organisms than an area with fewer, more scattered features (Gittings et al., 1992b). The Pinnacle Trend is a system of exposed hard substrates. Low-relief mounds, patch reefs, flat-top reefs, tall pinnacles, and ridge formations are often found in groups or clusters, creating a cumulative environment (Brooks, 1991). The reefs are richer because they are in proximity to each other. Even solitary, simple, low-relief mounds support low-diversity assemblages, which combine with major features to form a large reef tract. The Pinnacle Trend forms a major ecosystem with an influence that pervades the wider regional ecosystem.

Pinnacle Zonation

The characteristics of the substrate have a high degree of control over the composition of the biological communities that live on it. The features of the Pinnacle Trend are composed of carbonate reef material (Ludwick and Walton, 1957) and vary in shape, size, and vertical relief. The more complex the topographic shape of the substrate, the greater the variety of habitats for organisms and thus more high-density, biologically diverse communities. Shallow depressions and low mounds harbor some organisms, but the potential is limited. A pinnacle 20 m (66 ft) tall with slopes, cliffs, crevices, and overhangs may host the maximum number of species and a high density of animals (Gittings et al., 1992b). The bottom of a tall pinnacle will have very low diversity with mostly upright species present, such as comatulid crinoids; the ahermatypic hard coral, *Rhizopsammia manuelensis*; the black corals, *Antipathes* spp. and *Cirrhipathes* sp.; and the gorgonian, *Ellisella* sp. (Gittings et al., 1992b). The roughtongue bass, *Pronotogrammus martinicensis*, is the dominant fish at the base of pinnacles. Other common fish near the bottom are the red barbier, *Hemanthias vivanus*; cubbyu, *Pareques umbrosus*; bigeye soldierfish, *Ostichthys trachpoma*; and wrasse bass, *Liopropoma eukrines* (Weaver et al., 2002).

Features tall enough to rise above the common effects of turbidity have higher community diversity and density. At least 34 different epibenthic species were found during one study of the shelf-edge features (CSA, 1992b). Vertical walls were densely populated by *R. manuelensis*, with frequent occurrence of *Antipathes* spp., *Cirrhipathes luetkeni*, and *Ellisella* sp. Some other ahermatypic stony corals were also seen, including *Madrepora carolina*, *Madracis myriaster*, *Oculina diffusa*, and a solitary cup coral, possibly *Balanophyllia floridana*. Comatulid crinoids were also observed. This zone was dominated by the roughtongue bass and red barbier (Weaver et al., 2002).

The crests of the pinnacles are perhaps slightly more diverse than the walls. The same dominant species were seen as on the walls, with the common addition of the gorgonian coral, *Bebryce* sp. (Gittings et al., 1992b). Species richness is high at the crest of pinnacles, and *R. manuelensis* is very common. Coralline algae occur on hard substrates above about 78-m (256-ft) depth (Gittings et al., 1992b). The crests and walls of pinnacles are dominated by low-growing, ahermatypic hard corals. Fish communities on pinnacle crests are dominated by the red barbier; roughtongue bass; Gobiidae; greenband wrasse, *Halichoeres bathyphilus*; and yellowtail reeffish, *Chromis enchrysura* (Weaver et al., 2002).

Horizontal surfaces provide surface area for considerably higher biological cover than vertical surfaces. This is likely because a greater number of individuals are able to settle and colonize a horizontal surface (Gittings et al., 1992b). Dominant species are similar to those on the walls of the pinnacles. However, some species not present on vertical surfaces are found on horizontal surfaces, including several sponges (*Geodia neptuni*, *Cinachyrella* sp., and unidentified orange sponges) and a gorgonian coral, possibly *Nicella* sp. (Gittings et al., 1992b). The tops of reefs with extensive flat summits are dominated by the taller gorgonian corals, as well as by sponges and crinoids. It is likely that sedimentation limits the colonization of low-growing species on these horizontal surfaces, such as many of the ahermatypic hard corals (Gittings et al., 1992b). Dominant fish species on the flat tops include the red barbier, roughtongue bass, gobies, yellowtail reeffish, and greenband wrasse (Weaver et al., 2002).

Pinnacle Trend Field Studies

Within the Pinnacle Trend area, the feature known as "36 Fathom Ridge" was studied in some detail. The 36 Fathom Ridge is part of the Alabama Alps formation. Refer to **Figure 4-40** for the location and topography of this feature. It is 250 m (820 ft) wide and 1 km (0.6 mi) long and oriented in a north-south direction (Brooks and Giammona, 1990). The feature has a maximum relief of 16 m (52 ft), with the base 88 m (289 ft) below the sea surface and the crest 72 m (236 ft) below the surface (Weaver et al., 2002). The top of this feature is an irregular, fairly flat surface colonized by octocorals (*Bebryce cinerea*, *Bebryce grandis*, *Nicella* spp., *Ellisella* sp., *Cirrhipathes* sp., *Antipathes atlantica*, and *Ctenocella* spp.), crinoids (*Stichopathes lutkeni* and *Antipathes* sp.), gorgonians (*Astrocyclus caecilian*), ahermatypic coral (*Rhizopsammia manuelensis*), coralline algae, sea fans, ascidians, urchins, and sponges (*G. neptuni*) (CSA, 1992b; Thompson et al., 1999; Hardin et al., 2001). Flat sections of this feature are also covered by a silt to sand sediment veneer. The steep sides of the feature are dominated by a dense cover of *Rhizopsammia manuelensis*, a solitary coral. Comatulid crinoids, soft corals (*Antipathes* spp., *Cirrhipathes luetkeni*), some nonreef-building hard corals (*Madracis myriaster*, *Oculina diffusa*), coralline algae, and sponges are also present (CSA, 1992b; Thompson et al., 1999; Hardin et al., 2001). The walls of the feature were interspersed by some flat areas supporting even greater live cover including sponges (*Geodia neptuni*, *Cinachtrella* sp.), in addition to the vertical wall organism assemblage. The base of the feature supported low live cover that included the ahermatypic black coral *Rhizopsammia manuelensis*, several species of the Antipatharian, *Antipathes* sp., and several species of comatulid crinoids (CSA, 1992b; Thompson et al., 1999).

Other ridges that are smaller than 36 Fathom Ridge had very similar composition and amount of live cover as that of the 36 Fathom Ridge (CSA, 1992b). One of the mound-like features described by CSA (1992b) was located in water 94 m (308 ft) deep, was 11 m (36 ft) tall, 200 m (656 ft) wide, and 250 m (820 ft) long. The most common species colonizing the lower parts of the mound was *R. manuelensis*. There were also soft corals (*Ellisella* sp., *Cirrhipathes* sp.), comatulid crinoids, and antipatharians. Higher up on the mound, there was a greater density of *R. manuelensis*, together with the nonreef-building corals (*Madrepora carolensis*, *M. myriaster*, and *Oculina* sp.), antipatharians (*Antipathes* sp.), comatulid crinoids, and soft corals (*Nicella* sp.).

Roughtongue Reef (**Figure 4-41**) is an elliptical feature with a 400-m (1,300-ft) diameter base, a flat top covered with sediment, and steep sides (Weaver et al., 2002). A smaller reef is attached to the south.

Roughtongue Reef has a maximum relief of 14 m (46 ft), with the base at 78 m (256 ft) below the sea surface and the crest at 64 m (210 ft) below the surface (Weaver et al., 2002). Bioturbation from infaunal benthic organisms has been reported in the sediment on the top of the reef (Hardin et al., 2001). Organisms living on top of the reef are diverse and include octocorals (*Bebryce cinera*, *Bebryce grandis*, *Nicella* spp., *Thesea* sp., Stenogorgiinae, and *Ctenocella* spp); sponges (*Ulosa* sp., *Dysidea* sp., and *Ircinia campana*); crinoids; ectoprocts (*Cellaria* sp. and *Idmidronea* sp.); and an antipatharian spiral whip (*Stichopathes lutkeni*) (Hardin et al., 2001). The sides of Roughtongue Reef have a lower density of organisms and are dominated by *R. manuelensis*. The base of the feature also had *R. manuelensis*, along with octocoral fans and coral (*Madracis* sp., *Oculina* sp., and *Ctenocella* spp.) (Hardin et al., 2001). The roughtongue bass is also abundant here (Weaver et al., 2002).

Essential Fish Habitat

The NMFS has designated essential fish habitat (EFH) for coral species within the Pinnacle Trend area that are managed under fishery management plans (FMP) (USDOC, NMFS, 2010a). The EFH is defined as

> "**waters**—aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; **substrate**—sediment, hard bottom, structures underlying the waters, and associated biological communities; **necessary**—the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and **spawning, breeding, feeding, or growth to maturity**—stages representing a species' full life cycle" (USDOC, NMFS, 2010a).

Groups of coral protected under the Coral and Coral Reef FMP include octocorals, fire corals, stinging corals, stony corals, black corals, and deepwater corals (GMFMC and SAFMC, 1982). The EFH for coral in the Gulf of Mexico is designated for all life stages. The Magnuson-Stevens Act requires Federal agencies to consult with NMFS on actions that are to be federally permitted, funded, or undertaken that may have an adverse effect on EFH. Adverse effects are defined as "any impact that reduces quality and/or quantity of EFH . . . [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction of species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (USDOC, NMFS, 2010a). The BOEM is in the process of consulting with NMFS on a CPA proposed action. (See also Chapter 4.2.1.18, "Fish Resources and Essential Fish Habitat".).

Baseline Conditions following the *Deepwater Horizon* Event

Extensive literature, Internet, and database searches have been conducted for results of scientific data at pinnacle and low-relief, hard-bottom features following the DWH event. Although many research cruises have occurred, very few reports containing data have been released as of the publication of this EIS. Descriptions of studies in progress are discussed, and any results indicated are included below. A few early data releases have indicated that baseline conditions near the well may have been altered; however, impacts to hard-bottom areas farther from the well, including the Pinnacle Trend area are still unknown. Complete knowledge of impacts of the DWH event on the Pinnacle Trend area is currently unobtainable and likely not essential to making a reasoned choice among the alternatives presented in this EIS because, under a CPA proposed action, the Live Bottom (Pinnacle Trend) Stipulation, as well as other appropriate mitigation measures, would be applied where necessary.

The potential oiling footprint as reported through NOAA's Environmental Response Management Application (ERMA), posted on the GeoPlatform.gov website, indicated that oil was recorded in surface waters above the Pinnacle Trend area (USDOC, NOAA, 2011b). The oil was distributed in patches and ribbons rather than a continuous blanket of petroleum and migrated over time so that it did not have a continuous cover over the entire area for the duration of the spill (USDOC, NOAA, 2011b). The crests of the Pinnacle features rise up to as much as 20 m (66 ft) from the seafloor, at water depths between 60 and 120 m (200 and 400 ft) (Thompson et al., 1999; Schroeder, 2000). Pinnacles, therefore, are 40 m (130 ft) or more below the sea surface, which help to protect the epibenthic species from physical oil contact because their crests are deeper than the physical mixing ability of surface oil (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Thompson et al., 1999; Schroeder, 2000).

Water column hydrocarbon measurements collected during the DWH event suggest that it is unlikely that the pinnacle features were acutely affected by the oil or dispersed oil. Water samples collected by the R/V *Weatherbird* on May 23-26, 2010, located 40 nmi (74 km; 46 mi) and 45 nmi (83 km; 52 mi) northeast of the DWH rig revealed that concentrations of total petroleum hydrocarbons in the water column were less than 0.5 ppm (Haddad and Murawski, 2010). The total petroleum hydrocarbons concentrations 40 nmi (74 km; 46 mi) northeast of the well were 0.480 ppm and 0.114 ppm at 50-m (164 ft) and 100-m (328-ft) depth, respectively. The total petroleum hydrocarbons concentrations 45 nmi (83 km; 52 mi) northeast of the well were 0.174 ppm and 0.237 ppm at 50 m (164 ft) and 100 m (328 ft), respectively (Haddad and Murawski, 2010). The crests and bases of the Alabama Alps and Roughtongue Reef fall between these two water depths and are 40 nmi (74 km; 46 mi) north and 100 nmi (185 km; 115 mi) northeast of the well (Boland et al., 2010) (**Figures 4-40 and 4-41**). The measured total petroleum hydrocarbons in the water column near these features indicate the concentrations of total petroleum hydrocarbons that the hard-bottom features may have been exposed to were extremely low.

Data collected by OSAT (2010) also indicated that the pinnacle features were not likely acutely affected by the oil or dispersed oil. This study, which was more comprehensive than the study conducted from the R/V *Weatherbird*, indicated that PAH's were detected in the water column near the Pinnacles; however, the only exceedances of USEPA's aquatic life benchmarks were measured in the surface and near-surface waters at approximately 1 m (3 ft) in depth (OSAT, 2010; USDOC, NOAA, 2010u). The crests of the Pinnacles, which are 40 m (130 ft) or more below the water surface, would have protected them from physical oil contact because their crests are deeper than the physical mixing ability of surface oil (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Thompson et al., 1999; Schroeder, 2000). Any dispersed oil from the surface waters would have extremely low concentrations at the depth of the Pinnacles because of dilution in the water column with depth. Previous studies measured dispersed oil at 1 ppm at 10 m (33 ft) or less below the sea surface, a concentration which is below the lethal range to many corals (McAuliffe et al., 1981a; Lewis and Aurand, 1997; Dodge et al., 1984; Wyers et al., 1986; Kushmaro et al., 1997). All concentrations of dispersants in the water column near the Pinnacles were below USEPA's aquatic life benchmarks (OSAT, 2010). Although PAH's were detected in the sediments near the Pinnacle features, none of the samples exceeded USEPA's aquatic life benchmarks, and no dispersants were detected in the sediments near the Pinnacle features (OSAT, 2010; USDOC, NOAA, 2010v).

Concentrations of oil in the 1 ppm range, which is in the range of concentrations of dispersed oil reported from different sites in other studies (McAuliffe et al., 1981a; Lewis and Aurand, 1997), is higher than those recorded in the water column near the pinnacle or that which is anticipated to have mixed into the water column as a result of dispersant use, but there are concentrations likely to cause chronic or short-term impacts to corals, as opposed to acute toxicity (Dodge et al., 1984; Wyers et al., 1986; Kushmaro et al., 1997). Therefore, based on the concentrations of oil measured in the area, any impacts to coral in the Pinnacle Trend to the northeast of the well would likely be sublethal and may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment (Kushmaro et al., 1997; Loya, 1975 and 1976b; Rinkevich and Loya, 1977).

Although oil spills would normally impact surface features, the DWH event impacted some hard-bottom features located much closer to the well on the Mississippi-Alabama shelf than the Pinnacle Trend. Oil was detected in the CPA in a subsurface plume between water depths of 1,100 and 1,300 m (3,609 and 4,265 ft) and moving southwest along those depth contours (OSAT, 2010). Epibenthic organisms that protrude above the sediment may have been exposed to oil droplets in the water column or at the seafloor/water interface near the subsea plume. The strata where the subsea plume occurred were a place that scientists recorded visible impact to benthic organisms. A recent report documents damage to a deepwater (1,400 m; 4,593 ft) coral (gorgonian) community 11 km (7 mi) to the southwest of the well; the direction of travel of the subsea oil plume. The BOEMRE and NOAA dedicated part of their collaborative "Lophelia II Expedition: Oil Seeps and Deep Reefs" to investigate damage to deep corals as a result of the DWH event. A coral community in the CPA about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged and that the damage was the result of contact with the subsea oil plume (Fisher, 2010a; USDOI, BOEMRE, 2010j; White et al., 2012). See **Chapter 4.2.1.10** for a detailed description of the affected deepwater coral community.

Water and sediment samples collected during and after the spill were analyzed as part of the OSAT (2010) report. A handful of samples collected off the Gulf Coast did reveal some PAH as a result of the DWH event; however, there were no exceedances of USEPA aquatic life benchmarks measured near Pinnacle Trend features in either water or sediment (OSAT, 2010). There were 6 water samples out of 481 collected that exceeded USEPA's chronic toxicity benchmarks for PAH in the offshore waters (>3 nmi [3.5 mi; 5.6 km] offshore to the 200-m [656-ft] bathymetric contour), all of which occurred within 1 m (3.3 ft) of the water surface (OSAT, 2010). There were 63 water samples out of 3,605 collected from deep water (>200 m; 656 ft) that exceeded USEPA's aquatic life benchmarks for PAH (OSAT, 2010). Exceedances occurred near the water surface or in the southwest traveling deepwater plume within 70 km (43 mi) of the well. Oil detected in the subsurface plume was between 1,100 and 1,300 m (3,609 and 4,265 ft) and was moving southwest along those depth contours (OSAT, 2010), which is deeper than and in the opposite direction of the Pinnacle Trend features on the continental shelf. The oil in the deepwater plume was carried by deepwater currents, which do not transit up onto the continental shelf (Pond and Pickard, 1983; Inoue et al., 2008), protecting the Pinnacle Trend features. No sediment samples collected offshore (>3 nmi [3.5 mi; 5.6 km] offshore to the 200-m [656-ft] depth contour), and seven sediment samples collected in deep water (>200 m; 656 ft) exceeded USEPA's aquatic life benchmarks for PAH exposure (OSAT, 2010). All chronic aquatic life benchmark exceedances in the sediment occurred within 3 km (2 mi) of the well, and samples fell to background levels at a distance of 10 km (6 mi) from the well (OSAT, 2010). Dispersants were also detected in waters off Louisiana, but they were below USEPA's benchmarks of chronic toxicity. No dispersants were detected in sediment on the Gulf floor (OSAT, 2010). The Pinnacle Trend features, therefore, are not expected to be acutely impacted by PAH in the water column or sediment, as they are located much farther from the well than measured benchmark exceedances. However, chronic impacts may have occurred as a result of low-level or long-term exposure to dispersed, dissolved, or neutrally buoyant oil droplets in the water column.

The Macondo oil weathered as it traveled to the sea surface, floated on the sea surface, and traveled in the subsea plume, and it became depleted in lower molecular weight PAH's (which are the most acutely toxic components) (Brown et al., 2010; Eisler, 1987). The longer the oil spent in the water column or at the sea surface, the more diluted and weathered it became (Lehr et al., 2010). Chronic impacts that may result to species that came in contact with the diluted and weathered oil may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment (Kushmaro et al., 1997; Loya, 1975 and 1976b; Rinkevich and Loya, 1977). These types of possible impacts may be investigated in future studies if deemed necessary by NRDA.

Once more data are released, we will have a better understanding of the measured impacts and possible long-term effects of this event. The implementation of the proposed Live Bottom (Pinnacle Trend) Stipulation into lease sales, however, would serve to protect sensitive habitat from accidental impacts from oil and gas production, such as oil spills, by distancing production from the protected habitat. Details of how the proposed Live Bottom (Pinnacle Trend) Stipulation protects hard-bottom features in the Gulf of Mexico from routine and accidental impacts of petroleum production are discussed below.

Limited data are currently available on potential impacts of the DWH event on Pinnacle Trend features in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to Pinnacle Trend features. The BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives. Relevant data on the status of Pinnacle Trend features after the DWH event, however, may take years to acquire and analyze. Much of this data is being developed through the NRDA process, which may take years to complete. Little data from the NRDA process have been made available to date; therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In the place of this incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

4.2.1.6.1.2. Impacts of Routine Events

Background/Introduction

The vast majority of the Gulf of Mexico seabed is comprised of soft sediments. Live-bottom (Pinnacle Trend) features formed on hard-bottom substrate are interspersed along the continental shelf above the soft sediment. These Pinnacle Trend features, which sustain sensitive offshore habitats in the CPA, are listed and described in **Chapter 4.2.1.6.1.1**.

The routine activities associated with a proposed action that would impact Pinnacle Trend communities in the CPA include anchoring, infrastructure and pipeline emplacement, infrastructure removal, drilling discharges, and produced-water discharges. Seventy-four blocks are within the region defined as the Pinnacle Trend, which contains live bottoms that may be sensitive to oil and gas activities (**Figure 4-42)**. These blocks are located in the northeastern portion of the CPA and are located in water depths between 60 and 120 m (197 and 394 ft) in the Main Pass, Viosca Knoll, and Destin Dome lease areas. Relevant leases in past sales have contained a Live Bottom (Pinnacle Trend) Stipulation to protect such areas. The proposed Live Bottom (Pinnacle Trend) Stipulation is presented in **Chapter 2.4.1.3.2** as a potential mitigating measure for leases resulting from a CPA proposed action. The BOEM recommends the implementation of the Live Bottom (Pinnacle Trend) Stipulation for a proposed action within 1 of the 74 OCS lease blocks that has Pinnacle Trend features. The stipulation is designed to prevent drilling activities and anchor emplacement (the major potential impacting factors on these live bottoms resulting from offshore oil and gas activities) from damaging the pinnacle features. Under the stipulation, both exploration and development plans would be reviewed on a case-by-case basis to determine whether a proposed operation could impact a pinnacle feature. If it is determined from site-specific information derived from BOEM studies, published information from other research programs, geohazards survey information, or another source, that the operation would impact a pinnacle feature, the operator may be required to relocate the proposed operation. Clarification on how the proposed Live Bottom (Pinnacle Trend) Stipulation applies to operators is detailed in this Agency's NTL-2009-G39 (USDOI, MMS, 2009a).

Although the Live Bottom (Pinnacle Trend) Stipulation is regarded as a highly effective protection measure, infrequent impacts are possible. Impacts may be caused by operator positioning errors or when studies and/geohazards information are inaccurate or fail to note the presence of pinnacle features. One such incident has been documented and is discussed in further detail below. While investigating sites of previous oil and gas drilling activities, Shinn et al. (1993) documented that a lease operator had located an exploratory well adjacent to a medium-relief pinnacle feature; the reason for this occurrence is still undetermined. In spite of this documented instance, the stipulation is still considered effective since it allows BOEM flexibility to request any surveys or monitoring information for the protection of these sensitive areas. The impact analysis presented below is for routine activities associated with a CPA proposed action and includes application of the proposed Live Bottom (Pinnacle Trend) Stipulation.

A number of OCS-related factors may cause adverse impacts on the live-bottom communities and features. Damage caused by anchoring, infrastructure and pipeline emplacement, infrastructure removal, blowouts, drilling discharges, produced-water discharges, and oil spills can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible. Accidental impacts from oil spills and blowouts are discussed in **Chapter 4.2.1.6.1.3**.

Construction Impacts on Pinnacle Trend Features

Anchoring may damage lush biological communities or the structure of the live-bottom features themselves, which attract fish and other mobile marine organisms. Anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels greatly disturb areas of the seafloor and are the greatest threats to live-bottom areas at these depths. The size of the affected area would depend on water depth, anchor and chain sizes, chain length, method of placement, wind, and current. Anchor damage may result in the crushing and breaking of hard bottoms and associated communities. It may also result in community alteration through reduced or altered substrate cover, loss of sensitive species, and a reduction in coral cover in heavily damaged areas (Dinsdale and Harriott, 2004). Anchoring often destroys a wide swath of habitat by being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to corals as a result of anchoring may take 10 or more years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). Nearby species on these hard-bottom habitats that disperse larvae short distances, such as solitary species (cup corals, octocorals, and hydrocorals) may recolonize areas more rapidly than slow-growing colonial forms that disperse larvae great distances (Lissner et al., 1991). Pinnacle features would be protected from possible anchor damage through lease stipulations, as described in NTL 2009-G39. The proposed Live Bottom (Pinnacle Trend) Stipulation states that no bottom-disturbing activities are permitted within 30 m (100 ft) of the hard-bottom feature. Therefore, anchoring damage would only occur if the proposed stipulation is not followed.

The emplacement of infrastructure, including drilling rigs and platforms, on the seafloor would crush the organisms directly beneath the legs or mat used to support the structure. Pipeline emplacement directly affects the benthic communities by crushing them under the pipeline or trenching and burial of the pipeline (in less than 60-m [200-ft] water depth) and the resultant resuspension of sediments. These resuspended sediments may obstruct filter-feeding mechanisms and gills of fishes and sedentary invertebrates. The areas affected by the placement of the platforms and rigs are predominantly soft-bottom regions where the infaunal and epifaunal communities are not unique as are the hard-bottom communities.

Infrastructure and pipeline emplacement could result in suspended sediment plumes and sediment deposition on the seafloor. Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (approximately 2,000 metric tons [2,205 tons] for exploratory wells—900 metric tons [992 tons] of drilling fluid and 1,100 metric tons [1,213 tons] of cuttings—and slightly lower discharges for development wells) (Neff, 2005), potential impacts on biological resources of hard-bottom features should be expressly considered if drill sites occur in blocks containing such features. Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants.

Although the Live Bottom (Pinnacle Trend) Stipulation requires that no drilling be conducted within 30 m (98 ft) of pinnacles, some cuttings may reach the live-bottom features. Well cuttings that are disposed of at the water's surface tend to disperse in the water column and are distributed widely over a large area at low concentrations (CSA, 2004b; NRC, 1983). The heaviest concentrations of well cuttings and drilling fluids have been reported within 100 m (328 ft) of wells and are shown to decrease beyond that distance (CSA, 2004b; Kennicutt et al., 1996). The thickness of the deposition, however, is the potentially greater impacting factor for Pinnacle Trend features rather than the distance the cuttings are dispersed from the well. The cuttings rarely accumulate thicknesses >1 m (3 ft) immediately adjacent to the well; thicknesses are usually not higher than a few tens of centimeters (about 1 ft) in the GOM. They are usually distributed unevenly in gradients and in patches, often dependent on prevailing currents (CSA, 2004b). A gradient of deposition is generally limited to about 250 m (820 ft) from the well site, but may reach up to 500 m (1,640 ft) from the well, depending on prevailing currents and surrounding environmental conditions (Kennicutt et al., 1996; CSA, 2004b). Cuttings that accumulate on the seafloor should not completely cover organisms on pinnacles because the pinnacles have several meters relief above the seafloor and because the organisms are adapted to high levels of sedimentation.

In order to protect Pinnacle Trend features, the relocation of operations to avoid live-bottom areas, and monitoring to assess the impact of the activity may be required. These measures would limit or prevent well drilling activities from occurring in sensitive live-bottom areas. Also, the USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings to protect biological features. **Chapters 3.1.1.4.1 and 4.2.1.2.2** detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on offshore water quality and seafloor sediments. Due to the Live Bottom (Pinnacle Trend) Stipulation and USEPA discharge regulations, turbidity and smothering impacts of sessile invertebrates on hard-bottom features caused by drilling muds and cuttings are anticipated to be minimized.

Drilling fluid adhering to cuttings forms plumes that are rapidly dispersed on the OCS. Approximately 90 percent of the material discharged (cuttings and drilling fluid) settle rapidly to the seafloor, while 10 percent forms a plume of fine mud that drifts in the water column (Neff, 2005). Although drilling mud plumes may be visible 1 km (0.6 mi) from the discharge, rapid dilution of drilling mud plumes was reported within 6 m (20 ft) from the release point (Shinn et al., 1980; Hudson et al., 1982). Drilling muds and cuttings may be diluted 100 times at a distance of 10 m (33 ft) from the discharge and 1,000 times at a distance of 100 m (328 ft) from the discharge (Neff, 2005). Dilution continues with distance from the discharge point, and at 96 m (315 ft) from the release point, a plume was measured only a few milligrams/liter above background suspended sediment concentrations (Shinn et al., 1980). With consideration that drilling is not allowed within 30 m (100 ft) of pinnacles and considering that field measurements of suspended solids rapidly decline with distance from the source, turbidity impacts to live-bottom communities should be minimized.

Drilling mud concentrations at 6 m (20 ft) from the discharge were often lower than those produced during storms or from boat wakes, and at 96 m (315 ft) they were lower than suspended sediment concentrations measured on a windy day in coral reefs off Florida and far below concentrations measured to cause physiological impacts to corals (Shinn et al., 1980; Thompson et al., 1980; Szmant-Froelich et al., 1981; Kendall et al., 1983). The toxic effects measured as a result of exposure to drilling mud are not caused by turbidity alone, but also by the compounds in the drilling mud (Kendall et al., 1983). Extrapolation of data collected from bioassays indicates the no-effect concentration of drilling mud to be 3.99 ppm, which is above the average concentration of drilling mud measured in the water column 96 m (315 ft) from platforms (Kendall et al., 1983; Shinn et al., 1980). Based on those values, there should be no effects from drilling mud 96 m (315 ft) from a platform and possible limited effects at 6 m (20 ft) from the well.

It is not anticipated that muds drifting in the water column would exceed the natural turbidity levels in the Pinnacle Trend areas. The Pinnacle Trend community exists in a relatively turbid environment, starting just 65 km (40 mi) east of the mouth of the Mississippi River and trending to the northeast. The organisms in this area are tolerant of turbid environments (Rogers, 1990; Gittings et al., 1992a) and should not be impacted by the residual suspended sediment discharged during the drilling of a well. Many of the organisms that predominate in these communities also grow tall enough to withstand the sedimentation that results from their typical turbid environment or they have flexible structures that enable the passive removal of sediments (Gittings et al., 1992a). Their structure would also enable them to withstand the turbidity that may reach the live bottoms as a result of drilling of a well. Any mud that may reach these organisms can be removed by tentacle motion and mucus secretion (Shinn et al., 1980; Hudson and Robbin, 1980).

The resilience of some of the species found on pinnacle features was reported by Shinn et al. (1993). An exploratory well site erroneously located immediately adjacent to a 4-5 m (13-16 ft) high pinnacle feature, located at a water depth of 103 m (338 ft) was surveyed. Cuttings and drill debris were documented within 6,070 m^2 (1.5 ac) surrounding the drill site. In spite of being inundated by drill muds and cuttings 15 months prior to the investigation, the pinnacle feature was found to support a diverse community, which included gorgonians, sponges, nonreef-building stony corals, a species of horn coral, and abundant meter-long whip-like antipatharians characteristic of tropical hard-bottom communities in water depths of 30 m (100 ft) or greater. Shinn et al. (1993) concluded the following: "Gorgonians, antipatharians, crinoids, and non-reef-building corals attached to the pinnacle feature adjacent to the drill site as well as nearby rock bottom did not appear to be affected." Shinn et al. (1993) acknowledged that their evaluation of the drill site was constrained both by the lack of baseline data on the live-bottom community prior to inundation by drilling discharges and by the need for a study on long-term changes (e.g., 10 years).

Recruitment studies conducted by Continental Shelf Associates (CSA) and Texas A&M University, Geochemical and Environmental Research Group (GERG); Marine Resources Research Institute (MRRI); and others suggest that recovery of hard-bottom communities following physical damage, such as from the deposition of drilling discharges, will be slow (CSA and GERG, 2001; MRRI, 1984; Montagna and Holmberg, 2000). Hard-bottom communities studied during the Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring Program exhibit a dynamic sedimentary environment with relatively little net growth of the epibiota associated with the pinnacle features. Deeper habitats have slower rates of settlement, growth, and community development, and recruitment rates are reportedly slow in the pinnacle habitat (Montagna and Holmberg, 2000; CSA and GERG, 2001).

Epibiont recruitment showed relatively slow development of fouling community constituents on recruitment plates. Early colonizers are opportunistic epifauna, such as hydroids, bryozoans, barnacles, and bivalves that are tolerant of sediment loading (CSA and GERG, 2001; MRRI, 1984). Basically, only the earliest successional stages were observed after 1 year (MRRI, 1984) and after 27 months of exposure (CSA and GERG, 2001), and the epibiota typically associated with nearby hard-bottom features were rare on the plates (CSA and GERG, 2001). No sponges or corals had settled after 1 year (MRRI, 1984). Corals and sponges are known to display delayed recruitment and slow growth, and after 10 years, corals and anemones were sparse on artificial reef habitats and the community had still not reached "climax" state (MRRI, 1984).

The MRRI has noted that it is not known whether the results of the recruitment studies would have differed if the substrate had consisted of exposed patches of natural hard bottom; however, because analysis of artificial reefs exposed for months to several years also indicates slow community development, it can be anticipated that hard-bottom communities take a long time to recruit and develop (MRRI, 1984). Although settling plates and artificial reefs may differ from natural reefs, they can help to indicate recruitment time of a defaunated area (MRRI, 1984). This recruitment data indicates that, even though one survey showed thriving hard-bottom communities adjacent to a well 15 months after the well was drilled, drilling discharges are still considered to have a deleterious impact on the live-bottom communities, and the Live Bottom (Pinnacle Trend) Stipulation would continue to be applied to minimize the possibility of similar occurrences.

Long-Term and Operational Impacts on Pinnacle Trend Features

Drilling operations may impact live-bottom communities. Drilling operations in Puerto Rico have led to reduced coral cover out to 65 m (213 ft) from the well, probably as a result of cutting deposition (Hudson et al., 1982). Corals beyond this distance did not show reduced surface cover (Hudson et al., 1982). Live bottoms of pinnacle features may experience some deposition of cuttings, especially if a well is within a few hundred meters of a live bottom. Impacts as a result of cuttings disposal may reach 100-200 m (328-656 ft) from a well (Montagna and Harper, 1996; Kennicutt et al., 1996). The proposed Live Bottom (Pinnacle Trend) Stipulation requires all bottom-disturbing activity to be at least 30 m (100 ft) from the pinnacles. This distance is within the deposition zone measured as a result of drilling operations in the Gulf of Mexico (Montagna and Harper, 1996; Kennicutt at al., 1996). If BOEM determines that the proposed activity may adversely impact the feature, then the lessee may be required to undertake protective measures (e.g., relocation of operations) or to monitor the potential impact. The implementation of the Live Bottom (Pinnacle Trend) Stipulation is anticipated to reduce exposure pathways of drilling activities to benthic organisms on live bottoms, eliminating long-term operational impacts such as exposure to turbidity and sedimentation or associated contaminants.

Impacts resulting from exposure to contaminants may occur to live bottom organisms within 100-200 m (328-656 ft) of the well as a result of offshore oil and gas production (Montagna and Harper, 1996; Kennicutt et al., 1996; Hart et al., 1989; Kennicutt, 1995; CSA, 2004b). Sand content, metals, barium, inorganic carbon, and petroleum products have all been reported to be elevated near platforms (Kennicutt, 1995). Distribution of discharges tends to be patchy, have sharp gradients, and be directional (Kennicutt, 1995). The greatest impacts occur in low-energy environments where depositions may accumulate and not be redistributed (Neff, 2005; Kennicutt et al., 1996).

Elevated levels of barium, silver, cadmium, mercury, lead, and zinc were found out to 200 m (656 ft) from platforms and are likely a product of drilling muds and cuttings (Kennicutt et al., 1996; Hart et al., 1989; Chapman et al., 1991; CSA, 2004b). Metal concentrations in sediments near gas platforms (approximately out to 100 m [328 ft]) have been reported above those that may cause deleterious biological effects. Sublethal impacts to infauna have been reported out to 100 m (328 ft) from the platform. The impacts included reduced abundances, reduced survival, increased reproductive effort paired with reduced recruitment, and reduced genetic diversity (Montagna and Harper, 1996; Carr et al., 1996; Montagna and Li, 1997; Kennicutt, 1995). The impacts are believed to be a result of metal toxicity originating from drill cuttings during the installation of the well, which remain in the sediment (Montagna and Harper, 1996; Carr et al., 1996). Similar impacts could be expected for Pinnacle-associated organisms exposed to drill cuttings and muds.

Hydrocarbon enrichment has been reported within 25 m (82 ft) and out to 200 m (656 ft) of petroleum platforms, and the concentrations decreased with distance from the platforms (Hart et al., 1989; Chapman et al., 1991; Kennicutt, 1995; Kennicutt et al., 1996). The concentrations of PAH's in the sediment surrounding platforms, however, were below the biological thresholds for marine organisms and appeared to have little effect on benthic organisms (Hart et al., 1989; McDonald et al., 1996; Kennicutt et al., 1996). If any of the drill cuttings reach live-bottom features, impacts from metal or hydrocarbon exposure may occur. Although the literature does not report the impacts to gorgonians or soft corals as a result of exposure to contaminants in cuttings, infauna has shown effects including reduced fecundity, altered populations, and acute toxicity (Montagna and Harper, 1996; Carr et al., 1996; Kennicutt et al., 1996; Hart et al., 1989; Chapman et al., 1991; CSA, 2004b). Impacts to benthos would be reduced with distance from the discharge.

Produced waters are discharged at the water surface throughout the lifetime of the production platform and may contain hydrocarbons, trace metals, elemental sulfur, and radionuclides (Kendall and Rainey, 1991). Heavy metals enriched in the produced waters include cadmium, lead, iron, and barium (Trefry et al., 1995). Produced waters may impact both organisms attached to the production platform and benthic organisms in the sediment beneath the platform because the elements in the produced water may remain in the water column or attach to particles and settle to the seafloor (Burns et al., 1999). A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in **Chapter 4.2.1.2**.

Produced waters are rapidly diluted and impacts are generally only observed within proximity of the discharge point (Gittings et al., 1992a). Models have indicated that the vertical descent of a surface originating plume should be limited to the upper 50 m (164 ft) of the water column and maximum concentrations of surface plume water have been measured in the field between 8 and 12 m (26 and 39 ft) (Ray, 1998; Smith et al., 1994). Plumes have been measured to dilute 100 times within 10 m (33 ft) of the discharge and 1,000 times within 103 m (338 ft) of the discharge (Smith et al., 1994). Modeling exercises showed hydrocarbons to dilute 8,000 times within 1 km (0.6 mi) of a platform and constituents such as benzene and toluene to dilute 150,000 and 70,000 times, respectively, within that distance (Burns et al., 1999).

The less soluble fractions of the constituents in produced water associate with suspended particles and may sink (Burns et al., 1999). Particulate components were reported to fall out of suspension within 0.5-1 nmi from the source outfall (Burns et al., 1999). The particulate fraction disperses widely with distance from the outfall and soluble components dissolve in the water column, leaving the larger, less bioavailable compounds on the settling material (Burns et al., 1999). Due to the distance requirement for production platforms from Pinnacle Trend features, dispersion of particles in the water column, and currents around Pinnacle Trend features, the particulate constituents of produced waters should not impact biological communities on these live bottoms (Burns et al., 1999).

Waterborne constituents of produced waters can influence biological activity at a greater distance from the platform than particulate components can (Osenberg et al., 1992). The waterborne fractions travel with currents; however, data suggest that these fractions remain in the surface layers of the water column (Burns et al., 1999). Measurements of toluene, the most common dissolved hydrocarbon in produced waters, revealed rapid dilution with concentrations between 1 and 10 nanograms/liter (0.000001-0.00001 ppm) less than 2 km (1.2 mi) directly down current from the source and rapid dispersion much closer to the source opposite the current (King and McAllister, 1998). Monitoring studies of the Flower Garden Banks located less than 2 km (1.2 mi) from a production platform did not indicate negative effects throughout the duration of the platform’s operation, most likely due to the influence of currents (Gittings et al., 1992a). Many currents sweep around banks in the GOM instead of over them, which would protect reef organisms from contact with a produced-water plume (King and McAllister, 1998; Gittings et al., 1992a; Rezak et al., 1983; McGrail, 1982). A similar current action may occur around Pinnacle features. Modeling data for a platform in Australia indicated the plume would remain in the surface mixed layer (top 10 m; 33 ft) of the water column, which would further protect Pinnacle Trend features from produced water traveling with currents because crests of the Pinnacle features rise up to as much as 20 m (66 ft) from the seafloor, at water depths between 60 and 120 m (200 and 400 ft), placing them 40 m (130 ft) or more below the sea surface (Thompson et al., 1999; Schroeder, 2000; Burns et al., 1999).

Acute effects caused by produced waters are likely only to occur within the mixing zone around the outfall (Holdway, 2002). Past evaluation of the bioaccumulation of offshore, produced-water discharges conducted by the Offshore Operators Committee (Ray, 1998) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Possibly toxic concentrations of produced water were reported 20 m (66 ft) from the discharge in both the sediment and the water column where elevated levels of hydrocarbons, lead, and barium occurred, but no impacts to marine organisms or sediment contamination were reported beyond 100 m (328 ft) of the discharge (Neff and Sauer, 1991; Trefry et al., 1995). Another study in Australia reported that the average total concentration of 20 aromatic hydrocarbons measured in the water column 20 m (66 ft) from a discharge was <0.5 μg/L

(0.0005 mg/L or 0.0005 ppm) due to the rapid dispersion of the produced-water plume (Terrens and Tait, 1996).

Compounds found in produced waters are not anticipated to bioaccumulate in marine organisms. A study conducted on two species of mollusk and five species of fish (Ray, 1998) found that naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals. Metals including barium, cadmium, mercury, nickel, lead, and vanadium in the tissue of the clam, *Chama macerophylla*, and the oyster, *Crassostrea virginica*, collected within 10 m (33 ft) of discharge pipes on oil platforms were not statistically different from those located at reference stations (Trefry et al., 1995). Because high-molecular weight PAH's are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and they were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers (Ray, 1998).

Chronic effects including decreased fecundity; altered larval development, viability, and settlement; reduced recruitment; reduced growth; reduced photosynthesis by phytoplankton; reduced bacterial growth; alteration of community composition; and bioaccumulation of contaminants were reported for benthic organisms close to discharges and out to 1,000 m (3,281 ft) from the discharge (Holdway, 2002; Burns et al., 1999). Effects were greater closer to the discharges and responses varied by species. High concentrations of produced waters may have a chronic effect on corals. The Australian coral, *Plesiastrea versipora*, when exposed to 25 percent and 50 percent produced water, had a significant decrease in zooxanthellae photosynthesis and often bleached (Jones and Heyward, 2003). Experiments using water accommodated fractions (WAF) of produced waters indicated that coral fertilization was reduced by 25 percent and metamorphosis was reduced by 98 percent at 0.0721 ppm total hydrocarbon (Negri and Heyward, 2000). The WAF, however, is based on a closed experimental system in equilibrium and may be artificially low for the Gulf of Mexico, which will not reach equilibrium with contaminants. The experimental value can be considered a conservative approach that would overestimate impacts if the entire Gulf were to come in equilibrium with oil inputs.

Produced waters may have some impact on live-bottom features, but the Live Bottom (Pinnacle Trend) Stipulation should help to reduce these impacts. The greatest impacts are reported adjacent to the discharge and out to 20 m (66 ft) from the discharge, but they are substantially reduced less than 100 m (328 ft) from the discharge. Because no bottom-disturbing activities are permitted within 30 m (100 ft) of the pinnacles, produced waters would not be discharged within 30 m (100 ft) of the pinnacles. Since produced waters are rapidly dispersed, any elevated concentrations of compounds measured near outfalls should not reach Pinnacle Trend features due to the high dilution rates of produced waters (King and McAllister, 1998), influence of currents around features, and drilling distance required by the proposed Live Bottom (Pinnacle Trend) Stipulation. Also, USEPA's general NPDES permit restrictions on the discharge of produced water, which require the effluent concentration 100 m (328 ft) from the outfall to be less than the 7-day "no observable effect concentration" based on laboratory exposures, would help to limit the impacts on biological resources of Pinnacle Trend features (Smith et al., 1994). Measurements taken from a platform in the Gulf of Mexico showed discharge to be diluted below the "no observable effect concentration" within 10 m (33 ft) of the discharge (Smith et al., 1994). Such low concentrations would be even further diluted at greater distances from the well, limiting the impacts on biological resources of live bottoms.

Structure-Removal Impacts on Pinnacle Trend Features

The impacts of structure removal on live-bottom benthic communities can include turbidity, sediment deposition, explosive shock-wave impacts, and loss of habitat. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity that could impact surrounding live-bottom environments. Suspended sediment may evoke physiological impacts in benthic organisms including "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003). The higher the concentration of suspended sediment in the water column and the longer the sediment remains suspended, the greater the impact.

Sediment deposition that occurs in ahermatypic (nonreef-building) coral communities may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, and causing physical abrasion (Wilber et al., 2005). Corals may experience reduced coverage, changes in species diversity and dominance patterns, alterations in growth rates and forms, decreased calcification, increased production of mucus, lesions, reduced recruitment, and mortality (Torres et al., 2001; Telesnicki and Goldberg, 1995). Coral larvae settlement may be inhibited in areas where sediment has covered available substrate (Rogers, 1990; Goh and Lee, 2008).

Corals have some ability to rid themselves of sediment through mucus production and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995). Octocorals and gorgonians are more tolerant of sediment deposition than scleractinian corals, as they grow erect and are flexible, reducing sediment accumulation and allowing easy removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992a). Gorgonians, corals, and sponges on low-relief features have also been reported to protrude above accumulated sediment layers, and it is hypothesized that these organisms can resist burial by growing faster than the sediment accumulates over the hard substrate upon which they settle (Lissner et al., 1991).

The shock waves produced by explosive structure removals may also harm benthic biota. However, corals and other sessile invertebrates have a high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure-removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m (25 ft) away from the detonation of 135-kilogram (kg) (298-pound [lb]) charges in open water incurred a 5 percent mortality rate. Very few crabs died when exposed to 14-kg (31-lb) charges in open water 46 m (150 ft) away from the explosions. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods."

Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock wave is significantly attenuated when explosives are buried as opposed to detonation in the water column (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m (15 ft) below the seabed, as required by BSEE regulations, would further attenuate blast effects (Wright and Hopky, 1998).

Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf: Programmatic Environmental Assessment* (USDOI, MMS, 2005) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed Live Bottom (Pinnacle Trend) Stipulation in preventing platform emplacement in the most sensitive areas of the GOM. Impacts on the biotic communities, other than those on or directly associated with the platform, would be limited by the relatively small size of individual charges (normally 50 lb [27 kg] or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m (15 ft) below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive) (USDOI, MMS, 2005). Also, because the Live Bottom (Pinnacle Trend) Stipulation precludes platform installation within 30 m (100 ft) of a pinnacle feature, adverse effects to live-bottom features should be prevented.

Infrastructure or pipeline removal would impact the communities that have colonized the structures, many of which may also be found on live-bottom features. Removal of the structure itself would result in the removal of the hard substrate and the associated encrusting community. The overall community would experience a reduction in species diversity (both epifaunal encrusting organisms and the fish and large invertebrates that fed on them) with the removal of the structure (Schroeder and Love, 2004). The epifaunal organisms attached to the platform would die once the platform is removed. However, the seafloor habitat would return to the original soft-bottom substrate that existed before the well was drilled.

Some structures may be converted to artificial reefs. If the rig stays in place, the hard substrate and encrusting communities would remain part of the benthic habitat. The diversity of the community would not change and associated finfish species would continue to graze on the encrusting organisms. The community would remain an active artificial reef. However, plugging of wells and other reef-in-place decommissioning activities would still impact benthic communities as discussed above, since all the steps for removal except final removal from the water would still occur.

Proposed Action Analysis

The pinnacles in the CPA are located in the Main Pass, Viosca Knoll, and Destin Dome lease areas off Mississippi and Alabama within offshore Subareas between the coastline and 60 m (197 ft) of water (C0-60) (east of the Mississippi River Delta) and between 60 m and 200 m (197 and 656 ft) of water (C60-200). **Table 3-3** provides information regarding the level of proposed-action-related activities. For a CPA proposed action, 62-121 exploration/delineation wells, 78-152 development wells, and 28-54 production structures are projected for offshore Subareas C0-60. There are 24-46 exploration/delineation wells, 32-58 development wells, and 3-6 production structures projected for offshore Subareas C60-200. It is unlikely that many of the wells or production structures would be located in the Pinnacle Trend area because pinnacle blocks make up only 2 percent of the blocks in Subarea C0-60 (eastern) and 6 percent of the blocks in Subarea C60-200. If the Live Bottom (Pinnacle Trend) Stipulation is implemented, incidences of anchor damage from support vessels to pinnacle features would be avoided. Furthermore, as noted above, any platforms in this region would be placed so as to avoid pinnacle features for safety reasons as well as environmental protection. Thus, anchoring events are not expected to impact the resource. Anchor impacts, however, could occur by mistake, with recovery taking a few to many years, depending on the severity of the impact (Fucik et al., 1984; Rogers and Garrison, 2001; Lissner et al., 1991).

Pipeline emplacement also has the potential to cause considerable disruption to the bottom sediments in the vicinity of the live bottoms (**Chapter 3.1.1.8.1**); however, the implementation of the proposed Live Bottom (Pinnacle Trend) Stipulation, or a similar protective measure, would restrict pipeline-laying activities as well as oil and gas activities in the vicinity of the pinnacle communities. Data gathered for the Mississippi-Alabama Continental Shelf Ecosystem Study (Brooks, 1991) and the Mississippi/Pinnacle Trend Ecosystem Monitoring, Final Synthesis Report (CSA and GERG, 2001) document dense biological communities (i.e., live-bottom communities, fish habitat, etc.) on the high- and medium-relief pinnacle features themselves and the live-bottom organisms more sparsely distributed in unconsolidated bottom sediments surrounding the pinnacles. The actual effect of pipeline-laying activities on the biota of the pinnacle communities would be restricted to the resuspension of sediments. Burial of pipelines is only required in water depths of 60 m (200 ft) or less. Therefore, only the shallowest live-bottom communities would be affected by the increased turbidity associated with pipeline burial. The laying of pipeline without burial produces much less resuspension of sediments. The enforcement of the Live Bottom (Pinnacle Trend) Stipulation would help to minimize the impacts of pipeline-laying activities throughout the pinnacle region.

Effects of the Proposed Action without the Proposed Stipulation

The Pinnacle Trend features and associated biota of the CPA could be adversely impacted by oil and gas activities resulting from a CPA proposed action in the absence of the proposed Live Bottom (Pinnacle Trend) Stipulation (**Chapter 2.4.1.3.2**). This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected CPA Pinnacle Trend features. These impacting activities could include vessel anchoring and infrastructure emplacement; discharges of drilling muds, cuttings, and produced water; and ultimately the explosive removal of structures. All the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the biota found within the Pinnacle Trend. This may, in turn, reduce the habitat or shelter areas occupied by commercial and recreational fishes. Those areas actually subjected to mechanical disruption would be severely impacted.

Recovery from such disturbances could take 10 years or more in these deep environments (MRRI, 1984). Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Such activities would physically and mechanically alter benthic substrates and their associated biota. Construction discharges would cause substantial and prolonged turbidity and sedimentation, greater than natural conditions, possibly impeding the well-being and permanence of the biota and interfering with larval settlement, resulting in the decrease of live benthic cover. Finally, the unrestricted use of explosives to remove platforms installed in the vicinity of or on the Pinnacle Trend features could cause turbidity, sedimentation, and shock-wave impacts that would affect benthic biota.

Summary and Conclusion

Oil and gas operations discharge drilling muds and cuttings that generate turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings in the Pinnacle Trend area would not greatly impact the biota of the live bottoms because the biota surrounding the pinnacle features are adapted to turbid (nepheloid) conditions and high sedimentation rates associated with the outflow of the Mississippi River (Gittings et al., 1992a). The pinnacles themselves are coated with a veneer of sediment. Regional surface currents and water depth would largely dilute any effluent. Additional deposition and turbidity caused by a nearby well are not expected to adversely affect the pinnacle environment because such drilling muds and cuttings would be dispersed upon discharge. Mud contaminants measured in the Pinnacle Trend region reached background levels within 1,500 m (4,921 ft) of the discharge point (Shinn et al., 1993). Toxic impacts on benthos are limited to within 100-200 m (328-656 ft) of a well (Montagna and Harper, 1996; Kennicutt et al., 1996), and NPDES permit requirements limit discharge. The drilling of a well from a WPA proposed action, therefore, could have localized impacts on the benthos nearby the well; however, impacts would be reduced with distance from the well.

The toxicity of the produced waters has the potential to adversely impact the live-bottom organisms of the Pinnacle Trend; however, as previously stated, the proposed Live Bottom (Pinnacle Trend) Stipulation would prevent the placement of oil and gas facilities upon (and consequently would prevent the discharge of produced water directly over) the Pinnacle Trend live-bottom areas. Produced waters also rapidly disperse and remain in the surface layers of the water column, far above the peaks of Pinnacles.

Platform removals have the potential to impact nearby habitats. As previously discussed, the platforms are unlikely to be constructed directly on the pinnacles or low-relief areas because of the restraints placed by the Live Bottom (Pinnacle Trend) Stipulation, distancing blasts from sensitive habitats. Benthic organisms on live bottoms should also experience limited impact because they are resistant to blasts, tolerant of turbidity, can physically remove some suspended sediment, and may be located above or be tall enough to withstand limited sediment deposition. Live bottoms, however, may be impacted by heavy sediment deposition layers. The implementation of the Live Bottom (Pinnacle Trend) Stipulation would help to prevent such a smothering event. The proposed Live Bottom (Pinnacle Trend) Stipulation could prevent most of the potential impacts on live bottoms from bottom-disturbing activities (structure emplacement and removal) and operational discharges associated with a CPA proposed action. Any contaminants that reach live-bottom features would be diluted from their original concentration, so impacts that do occur should be sublethal.

4.2.1.6.1.3. Impacts of Accidental Events

Background/Introduction

The Pinnacle Trend features of the CPA that sustain sensitive offshore habitats are listed and described in **Chapter 4.2.1.6.1.1**. **Chapter 2.4.1.3.2** contains a complete description and discussion of the proposed Live Bottom (Pinnacle Trend) Stipulation. Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of live-bottom features of the CPA. A catastrophic events analysis is provided in **Appendix B**; nevertheless, the type and kind of expected impacts to Pinnacle Trend features from a catastrophic event would be similar to those described below as impacts from accidental events.

A Live Bottom (Pinnacle Trend) Stipulation similar to the one described in **Chapter 2.4.1.3.2** has been included in appropriate leases since 1973 and may, at the option of the ASLM, be made a part of appropriate leases resulting from a CPA proposed action. Although the lease stipulation was created to protect live-bottom features from routine impacts of drilling and production, it also protects the features from accidental impacts by distancing wells from them. The impact analysis of accidental events associated with a CPA proposed action presented here includes the proposed Live Bottom (Pinnacle Trend) Stipulation. As noted in **Chapter 2.4.1.3.2**, the proposed stipulation establishes that no bottom-disturbing activities may occur within 30 m (100 ft) of any hard bottoms/Pinnacles that have a vertical relief of 8 ft (2 m) or more, which distances these features from possible accidental impacts that could occur. Clarification on how the proposed Live Bottom (Pinnacle Trend) Stipulation applies to operators is detailed in this Agency's NTL-2009-G39 (USDOI, MMS, 2009a).

Possible Modes of Exposure

Oil released to the environment as a result of an accidental event may impact live-bottom features in several ways. Oil may be physically mixed into the water column from the sea surface, be injected below the sea surface and travel with currents, be dispersed in the water column, or adhere to particles and sink to the seafloor. These scenarios and their possible impacts are discussed in the following sections.

An oil spill that occurs at the sea surface would result in a majority of the oil remaining at the sea surface. Lighter compounds in the oil would evaporate, and some components of the oil may dissolve in the seawater. Evaporation removes the most toxic components of the oil, while dissolution may allow bioavailability of hydrocarbons to marine organisms for a brief period of time (Lewis and Aurand, 1997). The oil may also emulsify with water or sediment to particles and fall to the seafloor.

A spill that occurs below the sea surface (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would result in only a portion of the released oil rising to the sea surface. All known reserves in the Gulf of Mexico have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. As discussed in **Chapter 3.2.1.5.4**, oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column, surfacing almost directly over the source location, thus not impacting sensitive benthic communities. If the leak is deep in the water column and the oil is ejected under pressure, oil droplets may become entrained deep in the water column (Boehm and Fiest, 1982). The upward movement of the oil may be reduced if methane in the oil is dissolved into the water column at the high underwater pressures, reducing the oil's buoyancy (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but the smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010). Oil droplets <100 μm (0.004 in) in diameter may remain in the water column for several months (Joint Analysis Group, 2010a).

Impacts that may occur to benthic communities on live-bottom features as a result of a spill would depend on the type of spill, distance from the spill, relief of the biological feature, and surrounding physical characteristics of the environment (e.g., turbidity). The Live Bottom (Pinnacle Trend) Stipulation requires a 30-m (100-ft) buffer around hard bottoms or pinnacle features to prevent impacts to the seafloor features and associated biota. This Agency created the stipulation to protect hard-bottom habitats from disruption due to oil and gas activities. However, oil released during accidental events may possibly reach live-bottom features. As described above, a majority of the oil released from a spill would be expected to rise to the sea surface, therefore reducing the impact to benthic communities by direct oil exposure. However, small droplets of oil that are entrained in the water column may migrate into live-bottom habitat. Although these small oil droplets would not sink themselves, they may also attach to suspended particles in the water column and then be deposited on the seafloor (McAuliffe et al., 1975). Exposure to subsea plumes, dispersed oil, or sedimented oil may result in long-term impacts such as reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. These impacts are discussed in the following sections.

Surface Slicks and Physical Mixing

Surface oil slicks can spread over a large area; however, the majority of the slick is comprised of a very thin surface layer of oil moved by winds and currents (Lewis and Aurand, 1997). Oil spills have the potential to foul benthic communities and cause lethal or sublethal effects to organisms that the oil contacts as it is moved over the sea surface. Pinnacles are features that rise up to as much as 20 m (66 ft) from the seafloor, at water depths between 60 and 120 m (200 and 400 ft) (Thompson et al., 1999; Schroeder, 2000). Pinnacles, therefore, are 40 m (130 ft) or more below the sea surface. The depth of live-bottom features below the sea surface helps protect benthic species from physical oil contact.

Field data collected at the Atlantic entrance to the Panama Canal 2 months after a tanker spill has shown that subtidal coral did not show measurable impacts to the oil spill, presumably because the coral was far enough below the surface oil and the oil did not contact the coral (Rützler and Sterrer, 1970). A similar result was reported from a Florida coral reef immediately following and 6 months after a tanker discharged oil nearby (Chan, 1977). The lack of acute toxicity was again attributed to the fact that the corals were completely submerged at the time of the spill, and calm conditions prevented the oil from mixing into the water column (Chan, 1977).

Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10 m (33 ft). Modeling exercises have indicated that oil may reach a depth of 20 m (66 ft). Yet at this depth, the spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Therefore, the depth of live-bottom features below the sea surface should protect them from physical mixing of surface oil below the sea surface. However, if dispersants are used, they would enable oil to mix into the water column and possibly impact organisms on the live-bottom features. Dispersants are discussed later in this section.

Subsurface Plumes

A subsurface oil spill or plume could reach a live-bottom feature and would have the potential to damage the local biota contacted by oil. Such impacts on the biota may have severe and long-lasting consequences, including loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success.

Pinnacle features are protected from direct petroleum-producing impacts through stipulations written into lease sales, which distance these activities from Pinnacle features by creating a 30-m (100-ft) buffer around the features as described in NTL 2009-G39 (USDOI, MMS, 2009a). The distancing of petroleum-producing activities from live-bottom features allows for several physical and biological changes to occur to the oil before it reaches sensitive benthic organisms. Oil would become diluted as it physically mixes with the surrounding water. The longer and farther a subsea plume travels in the sea, the more dilute the oil will be (Vandermeulen, 1982; Tkalich and Chan, 2002). In addition, microbial degradation of the oil occurs in the water column, reducing toxicity (Hazen et al., 2010; McAuliffe et al., 1981b). The oil will move in the direction of prevailing currents (S.L. Ross Environmental Research Ltd., 1997); however, data has indicated that currents move around large topographic features (Rezak et al. , 1983; McGrail, 1982) and such movement would physically protect larger pinnacles and hard-bottom features by deflecting the subsea oil around the features rather than over them. Lower relief features, however, may not experience such diversion of currents. Subsea oil plumes transported by currents also may not travel nearly as far as surface oil slicks because some oil droplets may conglomerate and rise or may be blocked by fronts, as was observed in the southern Gulf of Mexico during the *Ixtoc* spill (Boehm and Fiest, 1982). Should any of the oil come in contact with adult sessile biota, effects would be primarily sublethal, as the oil may be diluted by physical and biological processes by the time it reaches the features. Low-level exposure impacts may vary from chronic to temporary, or even immeasurable.

Although the Live Bottom (Pinnacle Trend) Stipulation protects benthic organisms from petroleum-producing activity, it is possible that low levels of oil transported in subsea plumes may reach benthic features. Several studies have reported results for oil impacts on both hermatypic (reef-building) and ahermatypic (nonreef-building) corals, although ahermatypic corals are those that are found on Pinnacle features. Although not all of the same species studied are present in the Pinnacle Trend, impacts are expected to be similar. For example, coral feeding activity may be reduced if it is exposed to low levels of oil. Experiments indicated that normal feeding activity of *Porites porites* and *Madracis asperula* were reduced when exposed to 50 ppm oil (Lewis, 1971). Tentacle pulsation of an octocoral, *Heteroxenia fuscescens*, has also been shown to decrease upon oil exposure, although recovery of normal pulsation was observed 96 hours after the coral was removed from the oil (Cohen et al., 1977). *Porites furcata* exposed to Marine Diesel and Bunker C oil reduced feeding and left their mouths open for much longer than normal (Reimer, 1975).

Direct oil contact may result in coral tissue damage. Corals exposed to sublethal concentrations of oil for 3 months revealed atrophy of muscle bundles and mucus cells (Peters et al., 1981). *Porites furcata* submersed in Bunker C oil for 1 minute resulted in 100 percent tissue death, although the effect took 114 days to occur (Reimer, 1975).

Reproductive ability may also be reduced if coral is exposed to oil. A hermatypic coral, *Stylophora pistillata*, and an octocoral, *Heteroxenia fuscescens*, neither of which are present in the Gulf of Mexico, but may show impacts similar to those that could occur in the Gulf, shed their larvae when exposed to oil (Loya and Rinkevich, 1979; Rinkevich and Loya, 1977; Cohen et al., 1977). Undeveloped larvae in the water column have a reduced chance of survival due to predation and oil exposure (Loya and Rinkevich, 1979), which would in turn reduce the ability of larval settlement and reef expansion or recovery. A similar expulsion of gametes may occur in species that have external fertilization (Loya and Rinkevich, 1979), such as those at the Flower Garden Banks (Gittings et al., 1992c), which may then reduce gamete survivorship due to oil exposure.

The overall ability of a coral colony to reproduce may be affected by oil exposure. Reefs of *Siderastrea siderea* that were oiled in a spill produced smaller gonads than unoiled reefs, which resulted in reproductive stress for the oiled reef (Guzmán and Holst, 1993). *Stylophora pistillata* reefs exposed to oil had fewer breeding colonies, reduced number of ovaria per polyp, and significantly reduced fecundity compared with unoiled reefs (Rinkevich and Loya, 1977). Impaired development of reproductive tissue has also been reported for other reef-building corals exposed to sublethal concentrations of oil (Peters et al., 1981). Larvae may not be able to settle on substrate impacted by oil. Field experiments on *Stylophora pistillata* showed reduced settlement rate of larvae on artificial substrates of oiled reefs compared with control reefs and lower settlement rates, with increasing concentrations of oil in test containers (Rinkevich and Loya, 1977). Impaired larval settlement as a result of oiled substrate may lead to slow recovery of a disturbed substrate (CSA and GERG, 2001; MRRI, 1984; Montagna and Holmberg, 2000). Additionally, deeper habitats have slower rates of settlement, growth, and community development, and recruitment rates are reportedly slow in the Pinnacle habitat (Montagna and Holmberg, 2000; CSA and GERG, 2001). It is possible that corals may not recruit to an oiled substrate for 10 years (MRRI, 1984).

Corals exposed to subsea oil plumes may also incorporate petroleum hydrocarbons into their tissue. Records indicate that *Siderastrea siderea*, *Diploria strigosa*, *Montastrea annularis*, and *Heteroxenia fuscescens* have accumulated oil from the water column and have incorporated petroleum hydrocarbons into their tissues (Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992; Cohen et al., 1977). Most of the petroleum hydrocarbons were incorporated into the coral tissues, not their mucus (Knap et al., 1982). However, hydrocarbon uptake may also modify lipid ratios of coral (Burns and Knap, 1989). If lipid ratios are modified, mucus synthesis may be impacted, adversely affecting coral ability to protect itself from oil through mucus production (Burns and Knap, 1989). While these species are not present in the Pinnacle Trend area, similar effects may occur in Pinnacle-associated species.

Sublethal effects, although often hard to measure, could be long lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature and diseases) (Jackson et al., 1989; Loya, 1976a). Continued exposure to oil from resuspended contaminated sediments could also impact coral growth and recovery (Guzmán et al., 1994). Any repetitive or long-term oil exposure could inhibit coral larvae's ability to settle and grow, may damage coral reproductive systems, may cause acute toxicity to larvae, and may physically alter the reef, interfering with larval settlement, all of which would reduce coral recruitment to an impacted area (Kushmaro et al., 1997; Loya, 1975 and 1976a; Rinkevich and Loya, 1977). Exposure of eggs and larvae to oil in the water column may reduce the success of a spawning event (Peters et al., 1997). Although the impacts of exposure to sublethal concentrations of oil do not result in the acute toxicity that high concentrations may cause, sublethal exposure to oil may be detrimental to corals, as sublethal concentrations are typically widespread and have an overall community effect (Cohen et al., 1977). Therefore, the sublethal effects of oil exposure, even at very low concentrations, may result in compounded community impacts that have long-lasting effects.

Dispersed Oil

Chemically dispersed oil from a surface slick is not anticipated to result in lethal exposures to organisms on live-bottom features. The chemical dispersion of oil promotes the weathering process and increases the surface area available for bacterial biodegradation. It also allows surface oil to penetrate to greater depths than physical mixing would permit, and the dispersed oil will generally remain below the water's surface (McAuliffe et al., 1981b; Lewis and Aurand, 1997). However, reports on dispersant usage on surface plumes indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing sedimented oil traveling to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997).

Field experiments designed to test dispersant use on oil spills reported dispersed oil concentrations between 1 and 3 ppm, 9 m (30 ft) below the sea surface, approximately 1 hour after treatment with dispersant (McAuliffe et al., 1981a and 1981b). Other studies indicated that dispersed oil concentrations were <1 ppm, 10 m (33 ft) below the sea surface (Lewis and Aurand, 1997). The biological impacts that may occur from dispersant usage are greatest within the first hour of application and occur primarily to organisms living near the water's surface (Guillen et al., 1999). The above data indicate that the mixing depth of dispersed oil is less than the depths of the crests of Pinnacle Trend features (40 m [130 ft] or more below the sea surface), greatly reducing the possibility of exposure to dispersed surface oil.

Any dispersed surface oil that may reach the benthic communities of live-bottom features in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a). Such concentrations would not be life threatening to larval or adult stages based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Dispersants that are used on oil below the sea surface can travel with currents through the water and may contact benthic organisms on the live-bottom features. If the oil spill occurs near a live-bottom feature, the dispersed oil could be concentrated enough to harm the community. However, the longer the oil remains suspended in the water column traveling with currents, the more dispersed it would become. Weathering will also be accelerated and biological toxicity reduced (McAuliffe et al., 1981b). Although the use of subsea dispersants is a new technique and very little data are available on dispersion rates, it is anticipated that any oil that could reach live-bottom features on the continental shelf will be in low concentration based on surface slick dilution data (McAuliffe et al., 1981a; Lewis and Aurand, 1997). It is also anticipated that currents around the larger live-bottom features will sweep the subsea oil clear around the features (Rezak et al., 1983). Therefore, impacts resulting from exposure to dispersed oil are anticipated to be sublethal.

The report of damage to deepwater corals on the continental slope (USDOI, BOEMRE, 2010j) as a result of exposure to oil from the DWH may have resulted from the use of subsea dispersant at the source of the blowout. This situation was the first time subsea dispersants were used, and stratified density layers of water allowed the oil plume to remain at depth instead of dispersing into the water column (Joint Analysis Group, 2010a). It appears that density-bounded plumes eventually contacted the coral community. The decision to use dispersants is carefully weighed against the surrounding environment and anticipated environmental impacts, and the use of dispersants may not occur near protected habitats. For example, NOAA policy says that the application of dispersants must occur as far as possible from the Flower Garden Banks (Gittings, 2006). There is, however, no written policy for the application of dispersants near Pinnacle Trend features. The use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis.

Sublethal impacts that may occur to coral and other invertebrates exposed to dispersed oil may include reduced feeding, reduced reproduction and growth, physical tissue damage, and altered behavior. Short-term, sublethal responses of *Diploria strigosa* were reported after exposure to dispersed oil at a concentration of 20 ppm for 24 hours (Knap et al., 1983; Wyers et al., 1986). Although concentrations in this experiment were higher than what is anticipated for dispersed oil at depth, effects included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, localized tissue rupture (Wyers et al., 1986), and a decline in tentacle expansion behavior (Knap et al., 1983). Normal behavior resumed within 2 hours to 7 days after exposure (Wyers et al., 1986; Knap et al., 1983). This coral, however, did not show indications of stress when exposed to 1 ppm and 5 ppm of dispersed oil for 24 hours (Wyers et al., 1986). Investigations 1 year after *Diploria strigosa* was exposed to concentrations of dispersed oil between 1 and 50 ppm for periods between 6 and 24 hours did not reveal any impacts to growth (Dodge et al., 1984; Knap et al., 1983). It should be noted, however, that subtle growth effects may have occurred, but they were not measurable (Knap et al., 1983). This type of short-term exposure is what is anticipated to be possible if Pinnacle-associated organisms experience impacts from dispersed oil.

Historical studies indicated that dispersed oil in direct contact with organisms appeared to be more toxic to coral species than oil or dispersant alone. The greater toxicity may be a result of an increased number of oil droplets, resulting in greater contact area between oil and water (Elgershuizen and De Kruijf, 1976). The dispersant causes a higher water soluble fraction of oil contacting the cell membranes of the coral (Elgershuizen and De Kruijf, 1976). The mucus produced by coral, however, can protect an organism from oil. Both hard and soft corals have the ability to produce mucus; mucus production has been shown to increase when corals are exposed to crude oil (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Dispersed oil, which has very small oil droplets, does not appear to adhere to coral mucus, and larger untreated oil droplets may become trapped by the mucus barrier (Knap, 1987; Wyers et al., 1986). However, entrapment of the larger oil droplets may increase long-term exposure to oil if the mucus is not shed in a timely manner (Knap, 1987; Bak and Elgershuizen, 1976).

More recent field studies did not reveal as great an impact of dispersants on corals as were indicated in historical toxicity tests (Yender and Michel, 2010). This difference in reported damage probably resulted from a more realistic application of dispersants in an open field system and because newer dispersants are less toxic than the older ones (Yender and Michel, 2010). Field studies have shown oil to be dispersed to the part per billion level minutes to hours after the dispersant application, which is orders of magnitude below the reasonable effects threshold of oil in the water column (20 ppm) measured in some studies (McAuliffe, 1987; Shigenaka, 2001).

Although dispersed oil may be more toxic than untreated oil to corals during some exposure experiments (Shafir et al., 2007; Wyers et al., 1986; Cook and Knap, 1983), untreated oil may remain in the ecosystem for long periods of time, while dispersed oil does not (Baca et al., 2005; Ward et al., 2003). Twenty years after an experimental oil spill in Panama, oil and impacts from untreated oil were still observed at oil treatment sites, but no oil or impacts were observed at dispersed oil or reference sites (Baca et al., 2005). Long-term recovery of the coral at the dispersed oil site had already occurred as reported in a 10-year monitoring update, and the site was not significantly different from the reference site (Ward et al., 2003).

The time of year and surrounding ecosystem must be considered when determining if dispersants should be used. Dispersant usage may result in reduced or shorter term impacts to coral reefs; however, it may increase the impacts to other communities, such as mangroves (Ward et al., 2003). Therefore, dispersant usage may be more applicable offshore than in coastal areas where other species may be impacted as well. For example, the Flower Gardens Oil Spill Mitigation Workgroup discourages the use of dispersants near the Flower Garden Banks, especially from May to September when coral is spawning (Guillen et al., 1999). Mechanical oil cleanup is suggested during this time of year because coral larvae is sensitive to dispersants and the sea state is calm, allowing for mechanical removal (Guillen et al., 1999). A similar consideration might be made near the Pinnacles, but the use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis.

Sedimented Oil (Oil Adsorbed to Sediment Particles)

Smaller suspended oil droplets could be carried to the seafloor as a result of oil droplets adhering to suspended particles in the water column. Smaller particles have a greater affinity for oil (Lewis and Aurand, 1997). Oil may also reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Oiled sediment that settles to the seafloor may affect organisms attached to live-bottom features. It is anticipated that the greatest amount of sedimented oil would occur close to the spill, with lesser concentrations farther from the source. Studies after a spill that occurred at the Chevron Main Pass Block 41C Platform in the northern Gulf of Mexico revealed that the highest concentrations of oil in the sediment were close to the platform and the oil settled to the seafloor within 5-10 mi (8-16 km) of the spill site (McAuliffe et al., 1975). Therefore, if the spill occurs close to a live-bottom feature, the underlying benthic communities may be exposed to toxic hydrocarbons. However, because of the Live Bottom (Pinnacle Trend) Stipulation, which implements a 30-m (100-ft) buffer zone around Pinnacle features, these hard-bottom communities should be distanced from the heaviest oiled sedimentation effects.

Some oiled particles may become widely dispersed as they travel with currents while they settle out of suspension. Settling rates are determined by size and weight of the particle, salinity, and turbulent mixing in the area (Poirier and Thiel, 1941; Bassin and Ichiye, 1977; Deleersnijder et al., 2006). Because particles would have different sinking rates, the oiled particles would be dispersed over a large area, most likely at sublethal or immeasurable levels. Studies conducted after the *Ixtoc* oil spill revealed that, although oil was measured on particles in the water column, measurable petroleum levels were not found in the underlying sediment (ERCO, 1982). Based on BOEM restrictions and the settling rates and behavior of sedimented oil, the majority of organisms that may be exposed to sedimented oil are anticipated to experience low-level concentrations.

Sublethal impacts to benthic organisms may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. Experiments have shown that the presence of oil on available substrate for larval coral settlement has inhibited larval metamorphosis and larval settlement (Kushmaro et al., 1997). Crude oil concentrations as low as 0.1 ppm on substrate upon which the coral larvae were to settle reduced larval metamorphosis occurrences by 50 percent after 8 days of exposure. Oil concentrations of 100 ppm on substrates resulted in only 3.3 percent of the test population metamorphosizing (Kushmaro et al., 1997). There was also an increased number of deformed polyps after metamorphosis due to oil exposure (Kushmaro et al., 1997). It is also possible that recurring exposure may occur to coral if sedimented oil is resuspended locally, possibly inhibiting coral growth and recovery in the affected areas (Guzmán et al., 1994). Oil stranded in sediment is reportedly persistent and does not weather much (Hua, 1999), so coral may be repeatedly exposed to elevated concentrations of oil.

Adult coral, however, may be able to protect itself from low concentrations of sedimented oil through mucus production. Coral mucus may not only act as a barrier to protect coral from the oil in the water column, it has been shown to aid in the removal of oiled sediment on coral surfaces (Bak and Elgershuizen, 1976). Coral may use a combination of increased mucus production and ciliary action to rid themselves of oiled sediment (Bak and Elgershuizen, 1976).

Blowout and Sedimentation

Oil or gas well blowouts are possible occurrences in the OCS. Benthic communities exposed to large amounts of resuspended sediments following a subsurface blowout could be subject to sediment suffocation and exposure to toxic contaminants. Should oil or condensate be present in the blowout flow, liquid hydrocarbons could be an added source of negative impact on the benthos. The reduction of light that occurs during periods of sediment suspension will not impact the corals that live on Pinnacles because they are ahermatypic (they do not have zooxanthellae and do not require light for photosynthesis).

Suspended sediment that is transported by currents deep in the water column should not impact the benthic organisms on live-bottom features. Studies have shown that deep currents sweep around topographic features instead of over them, allowing the suspended sediment to remain at depth (Rezak et al., 1983; McGrail, 1982). A similar movement of water is anticipated around larger pinnacle features; therefore, suspended sediment or subsea oil plumes from depth should not be deposited on top of the elevated benthic organisms. However, lower relief features may experience slightly more deposition as currents may not sweep around them as much as the higher relief features.

Sediment that settles out of upper layers of the water column may impact benthic organisms of live-bottom features. Sediment deposition may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, and causing physical abrasion (Wilber et al., 2005). Corals may experience mortality or sublethal impacts such as reduced colony coverage, changes in species diversity and dominance patterns, alterations in growth rates and forms, decreased calcification, increased production of mucus, lesions, and reduced recruitment (Torres et al., 2001; Telesnicki and Goldberg, 1995; Rogers, 1990). Coral larvae settlement may also be inhibited in areas where sediment has covered available substrate (Rogers, 1990; Goh and Lee, 2008). Gorgonian larvae, for example, only settle on substrate that does not have accumulated sediment (Grigg, 1977). Impacts to corals as a result of sedimentation would vary based on coral species, the height to which the coral grows, degree of sedimentation, length of exposure, and the coral's ability to clear the sediment. Corals have some ability to rid themselves of sediment through mucus production and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995).

Solitary octocorals and gorgonians, which are abundant on many hard-bottom features, are tolerant of sediment deposition because these solitary species grow erect and are flexible, reducing sediment accumulation and allowing easy removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992a). Many of these organisms have even been observed to grow tall enough to resist burial during periods of sediment encroachment (Lissner et al., 1991). Due to the influence of the Mississippi River in the CPA, waters are more turbid near the outflow of the River, and more turbidity-tolerant species are present on live bottoms in this portion of the Gulf of Mexico. Because many of the species are more tolerant of turbidity and sedimentation, they could better survive exposure to increased sediment input that could result from an accidental event (Gittings et al., 1992a).

Since BOEM's proposed stipulation would preclude drilling within 30 m (100 ft) of a Pinnacle feature, most adverse effects on live-bottom features from blowouts would likely be prevented. Petroleum-producing activities would be far enough removed that heavy layers of sediment suspended as a result of a blowout should settle out of the water column before they reach sensitive biological communities. Other particles that travel with currents should become dispersed as they travel, reducing turbidity and depositional impacts. Furthermore, sediment traveling at depth should remain at depth instead of rising to the top of live-bottom features.

Response Activity Impacts

Oil-spill-response activity may also impact sessile benthic features. Booms anchored to the seafloor are sometimes used to control the movement of oil at the water surface. Boom anchors can physically impact corals and other sessile benthic organisms, especially when booms are moved around by waves (Tokotch, 2010). Vessel anchorage and decontamination stations set up during response efforts may also break or kill hard-bottom features as a result of setting anchors. Anchor damage may result in the crushing and breaking of hard bottoms and associated communities. It may also result in community alteration through reduced or altered substrate cover, loss of sensitive species, and a reduction in coral cover in heavily damaged areas (Dinsdale and Harriott, 2004). Anchoring often destroys a wide swath of habitat by the anchor being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to corals as a result of anchoring may take 10 or more years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). Nearby species on these hard-bottom habitats that disperse larvae short distances, such as solitary species (cup corals, octocorals, and hydrocorals), may recolonize areas more rapidly than slow-growing colonial forms that disperse larvae great distances (Lissner et al., 1991). Effort should be made to keep vessel anchorage areas away from sensitive benthic features to minimize impact.

Drilling muds comprised primarily of barite may be pumped into a well to stop a blowout. If a "kill" is not successful, the mud may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on the BOEM stipulation contained in NTL 2009-G39, a well should be far enough away from live-bottom features to prevent extruded drilling muds from smothering sensitive benthic communities. However, if drilling muds were to travel far enough or high enough in the water column to contact a hard-bottom community, the fluid may smother the existing community. Low-relief communities would be more at risk for burial than those on higher pinnacles. Experiments indicate that corals perish faster when buried beneath drilling mud than when buried beneath carbonate sediments (Thompson, 1979). Light layers of deposited sediment would most likely be removed by mucus and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995).

Proposed Live Bottom (Pinnacle Trend) Stipulation

The proposed Live Bottom (Pinnacle Trend) Stipulation is a potential mitigating measure for leases resulting from a CPA proposed action. The stipulation is designed to prevent routine petroleum-producing activities from damaging the Pinnacle Trend features. Under the stipulation, plans would be reviewed on a case-by-case basis to determine whether a proposed operation could impact a Pinnacle Trend area. If it is determined from site-specific information derived from BOEM studies, published information from other research programs, geohazards survey information, or another source that the operation would impact a Pinnacle Trend area, the operator may be required to relocate the proposed operation.

Although the BOEM stipulation prevents oil and gas drilling activity within 30 m (100 ft) of Pinnacle features, some effects may occur to benthic organisms as a result of an oil spill. Sublethal impacts may include exposure to low levels of oil, dispersed oil, or sedimented oil and turbidity and sedimentation from disturbed sediments. Effects from these exposures may include reduced growth, altered behavior, decreased community diversity, altered community composition, reduction in coral cover, and reduced reproductive success. The severity of these impacts may be dependent on the concentration and duration of exposure. If concentrated oil is carried to live-bottom habitats in a subsea plume, severe lethal effects could result to localized community habitats (Dodge et al., 1984; Wyers et al., 1986). Recovery could take 10 years or more (MRRI, 1984; Fucik et al., 1984; Rogers and Garrison, 2001).

Proposed Action Analysis

Accidental releases of oil could occur as a result of a CPA proposed action. Small spills (0-1.0 bbl) would have the greatest number of occurrences (**Table 3-12**). Estimates of the number of small scale releases as a result of a CPA proposed action ranges from 929 to 1,806 spills. These spills would be small in volume and rapidly diluted by surrounding water. A large-scale spill, ≥1,000 bbl, is very unlikely, and based on historical spill rates and projected production for a CPA proposed action, up to one spill of this volume is possible as a result of a CPA proposed action. If a large scale release of oil were to occur, impacts would be more widely spread.

The probability of surface water oiling occurring as a result of a CPA proposed action anywhere between the shoreline and 300-m (984-ft) depth contour, which is where the Pinnacle features are located, was estimated by the Bureau of Ocean Energy Management's OSRA model for spills ≥1,000 bbl. For the Mississippi polygon, the OSRA model estimated probabilities of 3-6 percent and 4-8 percent after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**). For the Alabama polygon, the OSRA model estimated probabilities of 2-5 percent and 4-7 percent after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**).

A large-scale spill, ≥1,000 bbl, is very unlikely, and based on historical spill rates and projected production for a CPA proposed action, up to one spill of this volume is possible as a result of a CPA proposed action.

Probabilities of oil contacting the surface water above HAPC's in the CPA, including the Pinnacle Trend was 2-6 percent (**Figure 3-25**).

The Pinnacle Trend occupies 74 lease blocks in the northeastern portion of the CPA and is protected from impacts from oil and gas activity. The Pinnacle Trend blocks represent a small fraction of the continental shelf area in the CPA. The fact that the Pinnacle Trend features are widely dispersed, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to the Pinnacle Trend.

The shallowest water depth over any features of the Pinnacle Trend in the CPA is about 60 m (200 ft). When surface spills are mixed into the water column, the oil is not expected to penetrate below a depth of about 10 m (33 ft). Also, the low probabilities of oil reaching the surface waters above these features, based on the OSRA model, combined with the limited depth of mixing of surface oil to the crests of these features function to protect these features. However, the use of dispersants could result in oil mixing into the water column and potentially reaching Pinnacle Trend communities. As stated above, the use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis. The BOEM considers it unlikely that concentrated dispersants would be applied near Pinnacle Trend features, but the decision on how and where to use dispersants is outside of BOEM's control. Sedimented oil or sedimentation as a result of a blowout near a Pinnacle Trend community may impact benthic organisms.

Potential impacts to the Pinnacle Trend from oil spills and blowouts from a CPA proposed action are unlikely and are not expected to be significant. The proposed Live Bottom (Pinnacle Trend) Stipulation would assist in preventing most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of the Pinnacle Trend.

Effects of the Proposed Action without the Proposed Stipulation

The live-bottom features and associated biota of the CPA could be adversely impacted by oil and gas activities resulting from a CPA proposed action should it not be restricted by the proposed Live Bottom (Pinnacle Trend) Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected live-bottom and Pinnacle Trend features. The area within the restricted zones would probably be the areas of the live-bottom features that are most susceptible to adverse impacts if oil and gas activities are not restricted by the Live Bottom (Pinnacle Trend) Stipulation or project-specific mitigating measures. These impacting factors would include blowouts, surface oil spills, and subsea oil spills, along with oil-spill-response activities such as the use of dispersants. Potential impacts from routine activities resulting from a CPA proposed action are discussed in **Chapter 4.2.1.6.1.2**.

Oil spills as well as routine activities have the potential to considerably alter the diversity, cover, and long-term viability of the biota found on live-bottom features. Direct oil contact may result in acute toxicity (Dodge et al., 1984; Wyers et al., 1986). In most cases, recovery from disturbances would take 10 years or more (MRRI, 1984; Fucik et al., 1984; Rogers and Garrison, 2001). As stated above, the use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis. The BOEM considers it unlikely that concentrated dispersants would be applied near Pinnacle Trend features, but the decision on how and where to use dispersants is outside of BOEM's control.

Indeed, disturbances, including oil spills and blowouts, would alter benthic substrates and their associated biota, especially close to the discharge. In the unlikely event of a blowout, sediment resuspension (potentially with associated oil) could cause adverse turbidity and sedimentation conditions. In addition to affecting the benthic cover of a live-bottom feature, a blowout could alter the local benthic morphology, thus irreversibly altering the live-bottom community. Oil spills (surface and subsea) could be harmful to the local biota should the oil have a prolonged or recurrent contact with the organisms. Therefore, in the absence of the Live Bottom (Pinnacle Trend) Stipulation, a CPA proposed action could cause long-term (10 years or more) adverse impacts to the biota of the live-bottom features in the event of a spill.

Summary and Conclusion

Live-bottom (Pinnacle Trend) features represent a small fraction of the continental shelf area in the CPA. The small portion of the seafloor covered by these features, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to the Pinnacle Trend features.

The proposed Live Bottom (Pinnacle Trend) Stipulation (**Chapter 2.4.1.3.2**), if applied, would prevent most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of Pinnacle Trend features by increasing the distance of such events from the features. It would be expected that the majority of oil would rise to the surface and that the most heavily oiled sediments would likely be deposited before reaching the Pinnacle features. However, operations outside the proposed buffer zones around sensitive habitats (including blowouts and oil spills) may affect live-bottom features.

The depth below the sea surface to which many live-bottom features rise helps to protect them from surface oil spills. Some Pinnacles may rise to within 40 m (130 ft) of the sea surface; however, many features have much less relief or are in deeper water depths. Any oil that might contact pinnacle features would probably be at low concentrations because the depth to which surface oil can mix down into the water column is less than the peak of the tallest pinnacles, and this would result in little effect to these features.

A subsurface spill or plume may impact sessile biota of live-bottom features. Oil or dispersed oil may cause sublethal impacts to benthic organisms if a plume reaches these features. Impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. The Live Bottom (Pinnacle Trend) Stipulation would limit the potential impact of such occurrences by keeping the sources of such adverse events geographically removed from the sensitive biological resources of live-bottom features.

Sedimented oil or sedimentation as a result of a blowout may impact benthic organisms. However, because the Live Bottom (Pinnacle Trend) Stipulation places petroleum-producing activity at a distance from live-bottom features, this would result in reduced turbidity and sedimentation near the sensitive features. Furthermore, any sedimented oil should be well dispersed, resulting in a light layer of deposition that would be easily removed by the organism and have low toxicity.

The proposed Live Bottom (Pinnacle Trend) Stipulation would assist in preventing most of the potential impacts on live-bottom communities from blowouts, surface, and subsurface oil spills and the associated effects. Any contact with spilled oil would likely cause sublethal effects to benthic organisms because the distance of activity would prevent contact with concentrated oil. In the unlikely event that oil from a subsurface spill would reach the biota of a live-bottom feature, the effects would be primarily sublethal and impacts would be at the community level. Any turbidity, sedimentation, and sedimented oil would also be at low concentrations by the time the live-bottom features were reached, resulting in sublethal impacts.

4.2.1.6.1.4. Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a proposed action plus those related to prior and future OCS lease sales, and to tanker and other shipping operations that may occur and adversely affect live bottoms of the Pinnacle Trend area. Specific OCS-related, impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, blowouts, and operational discharges. Non-OCS-related impacts including commercial fisheries, natural disturbances, anchoring by recreational boats, and other non-OCS commercial vessels, as well as spillage from import tankering, all have the potential to alter live bottoms, and they are addressed here as well.

It is assumed that the Live Bottom (Pinnacle Trend) Stipulation for live bottoms would be part of appropriate OCS leases and that existing site/project-specific mitigations would be applied to OCS activities on these leases or supporting activities on these leases. The Live Bottom (Pinnacle Trend) Stipulation does not permit bottom-disturbing activities within 30 m (100 ft) of any hard bottom or pinnacle. However, stipulations and mitigations do not protect the resources from activities outside of BOEM jurisdiction (i.e., commercial fishing, tanker and shipping operations, or recreational activities).

OCS Leasing-Related Impacts

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels that disturb areas of the seafloor are considered the greatest oil and gas OCS-related threat to Pinnacle live-bottom areas. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current (Lissner et al., 1991). Anchor damage could include crushing and breaking of live bottoms and associated communities. It may also result in community alteration through reduced or altered substrate cover, loss of sensitive species, and a reduction in coral cover in heavily damaged areas (Dinsdale and Harriott, 2004). Anchoring often destroys a wide swath of habitat by the anchor being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to corals as a result of anchoring may take 10 or more years from which to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). Nearby species on these hard-bottom habitats that disperse larvae short distances, such as solitary species (cup corals, octocorals, and hydrocorals), may recolonize areas more rapidly than slow-growing colonial forms that disperse larvae great distances (Lissner et al., 1991). Such anchoring damage, however, should be minimized on pinnacle habitats, as stipulations included in the leases do not allow bottom-disturbing activities within 30 m (100 ft) of the hard-bottom feature, as described by NTL 2009-G39 (USDOI, MMS, 2009a).

Both explosive and nonexplosive structure-removal operations disturb the seafloor; however, they are not expected to affect hard-bottom communities because of stipulation required buffer distances of 30 m (100 ft) and because many sessile benthic organisms are known to resist the concussive force of structure-removal-type blasts (O'Keeffe and Young, 1984). Also, BSEE regulations require charges to be detonated 5 m (15 ft) below the mudline and at intervals of at least 0.9 seconds, which would attenuate shock waves in the seafloor, reducing shock impact to hard bottoms on the seafloor (Baxter et al., 1982). Should pinnacle communities incur any damages as a result of the explosive removal of structures, recruitment and succession of the communities would be slow and may take more than 10 years (Montagna and Holmberg, 2000; CSA and GERG, 2001; MRRI, 1984).

Routine discharges of drilling muds and cuttings by oil and gas operations could affect biological communities and organisms through a variety of mechanisms, including the smothering of organisms through deposition or less obvious sublethal effects (impacts to growth and reproduction). The Live Bottom (Pinnacle Trend) Stipulation, however, requires that drilling occur at least 30 m (100 ft) from pinnacles, which helps protect these features through physical distance from wells. Even though the additive effects of drilling several wells add more discharges to the environment, the Live Bottom (Pinnacle Trend) Stipulation protects these sensitive communities through distance from drilling.

Drilling muds quickly disperse upon release, and most of the material is rapidly deposited on the seafloor (Neff, 2005; Shinn et al., 1980; Hudson et al., 1982). The drilling fluid plume in the water column has been measured to be only a few milligrams/liter above background sediment concentrations 100 m (328 ft) from the discharge point, concentrations often less than those produced during storms or from boat wakes (Shinn et al., 1980). Deposition of drilling muds and cuttings in pinnacle habitats are not expected to greatly impact the biota of the surrounding habitat for three reasons. First, the biota that live on the pinnacles are adapted to turbid conditions and storm impacts (Gittings et al., 1992a), reducing their vulnerability to sedimentation. Second, the Live Bottom (Pinnacle Trend) Stipulation does not allow drilling within 30 m (100 ft) of a pinnacle, placing physical distance between the well and the sensitive environment in which the cuttings may travel to the seafloor. Third, USEPA discharge regulations and permits would further reduce discharge-related impacts. Any exposure that may occur from muds and cuttings discharged as a result of the cumulative scenario would be temporary, primarily sublethal in nature, and the effects would be limited to small areas.

Produced waters from petroleum operations that are released at the water's surface are not likely to have a great impact on pinnacles. Produced waters are rapidly diluted, impacts are generally only observed within proximity of the discharge point, and acute toxicity that may result from produced waters occurs "within the immediate mixing zone around a production platform" (Gittings et al., 1992b; Holdway, 2002). Also, USEPA's general NPDES permit restrictions on the discharge of produced water, require the effluent concentration 100 m (328 ft) from the outfall to be less than the 7-day "no observable effect concentration" based on laboratory exposures, (Smith et al., 1994).

The Live Bottom (Pinnacle Trend) Stipulation and site-specific mitigations are expected to prevent operators from placing pipelines directly upon live-bottom communities. The effect of pipeline-laying activities on the biota of these communities would be restricted to the resuspension of sediments, possibly causing obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Impacts may include "changes in respiration rate, . . . abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003). Since burial of pipelines is not required in water depths >60 m (200 ft), very little of the Pinnacle Trend area (≥60-m [200-ft] depth) would be subjected to high turbidity caused by burial during pipeline-laying activities.

Oil spills may have an impact on the Pinnacle communities of the Gulf of Mexico. The Live Bottom (Pinnacle Trend) Stipulation would help protect hard-bottom communities from experiencing direct oiling as a result of a blowout because bottom-disturbing activities are not permitted within 30 m (100 ft) these communities. Also, the depth of pinnacle features (60-120 m; 200-400 ft) helps protect them from fouling by oil. Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10-20 m (33-66 ft) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Pinnacles rise up to 20 m (66 ft) above the seafloor, at water depths between 60 and 120 m (200 and 400 ft) (Thompson et al., 1999; Schroeder, 2000). Pinnacles, therefore, are 40 m (130 ft) or more below the sea surface. The depth of the live-bottom features below the sea surface helps protect benthic species from physical oil contact.

Any dispersed surface oil from a tanker or rig spill that may reach the benthic communities of pinnacles in the Gulf of Mexico would be expected to be at very low concentrations (less than 1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations would not be life threatening to larval or adult stages based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed or physically mixed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Potential blowouts are unlikely to impact the biota of the pinnacles because the Live Bottom (Pinnacle Trend) Stipulation does not allow drilling within 30 m (100 ft) of a pinnacle. Therefore, these sensitive habitats are distanced from the potential lethal impacts of a blowout. Oil leaked at the seafloor would rise to the sea surface because all known reserves in the Gulf of Mexico have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. If any blowouts from wells did occur, the suspended sediments should settle out of the water column before a majority of the material reached a pinnacle. Subsea oil will be dispersed as it travels in the water column (Vandermeulen, 1982; Tkalich and Chan, 2002). Also, because currents are anticipated to sweep around the larger pinnacle features instead of over them, subsea oil should be directed away from the larger features, reducing the possibility of physical oiling or deposition of oiled sediment (Rezak et al., 1983; McGrail, 1982). If oil were to contact the live-bottom features, concentrations would be sublethal unless the source is close to the feature. The impacts of physical contact may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. In the highly unlikely event that oil from a subsurface spill could reach a Pinnacle area in lethal concentrations, the recovery of this area could take in excess of 10 years (Fucik et al., 1984).

In the unlikely event a freighter, tanker, or other oceangoing vessel related to OCS Program activities sank and collided with pinnacle features or associated habitat, releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time. At present, such an event has never occurred, so information on habitat recovery capabilities is based on recovery studies from other forms of physical damage to hard-bottom features. For the purpose of this analysis, it is projected that no surface spills, regardless of size, would have an impact on the biota of pinnacles, largely because the tops of the features crest at depths greater than 40 m (130 ft) below the sea surface. Surface oil spills are therefore not expected to impact the pinnacle communities, as discussed above.

The greatest impact from an oil spill could result from dispersed oil trapped in stratified layers of water, such as that which occurred during the DWH event. A recent report documents damage to a deepwater coral community 11 km (7 mi) southwest of the DWH event (USDOI, BOEMRE, 2010j) at a depth where a dispersed plume of oil was trapped in a stratified water layer (OSAT, 2010). A probable explanation for the detrimental impacts to corals is that the coral community forms structures that protrude up into the water column that would be affected by a passing oil plume. The DWH event was the first usage of subsea dispersants, but if subsea dispersants are ever applied on the continental shelf, a similar occurrence may happen. A stratified nepheloid (turbid) layer exists near the seafloor and rises to 20 m (66 ft) from the seafloor and, if a dispersant is used in that layer near the Pinnacles, dispersed oil could affect the sensitive communities. As stated above, the use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis. The BOEM considers it unlikely that concentrated dispersants would be applied near Pinnacle Trend features, but the decision on how and where to use dispersants is outside of BOEM's control.

Should the Live Bottom (Pinnacle Trend) Stipulation not be implemented for a proposed action or for future lease sales, OCS activities could have the potential to destroy part of the biological communities and damage one or several live/hard-bottom features. The most potentially damaging of these are the impacts associated with physical damages that may result from anchors, structure emplacement, and other bottom-disturbing operations.

As noted in the affected environment description, limited data are currently available on potential impacts of the DWH event on Pinnacle Trend features in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to Pinnacle Trend features. The BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives. Relevant data on the status of Pinnacle Trend features after the DWH event, however, may take years to acquire and analyze. Much of this data is being developed through the NRDA process, which is expected to take years to complete. Little data from the NRDA process has been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In the place of this incomplete or unavailable information, as noted above, BOEM subject-matter experts have used available scientifically credible evidence in this analysis applied using accepted scientific methods and approaches.

The cumulative impact of possible oil spills, along with the DWH event, is not anticipated to affect the overall Pinnacle Trend habitat. The Live Bottom (Pinnacle Trend) Stipulation would not allow wells to be drilled within 30 m (100 ft) of a pinnacle, separating the habitat from the worst of the sediment deposition of a blowout and allowing most of the oil to rise to the sea surface without contacting pinnacle features. If oil is released near a pinnacle feature and concentrated or dispersed oil is entrained in the water column, it could contact nearby pinnacle habitat with serious detrimental effects. Habitats receiving high concentrations of oil could take 10 or more years to recover (Fucik et al., 1984). However, since subsea plumes travel directionally with water currents, only pinnacle habitats directly in the path of the plume would be affected. Therefore, the acute impacts of any large-scale blowout would likely be limited in scale, and any additive impacts of several blowouts should only impact small areas on an acute level, with possible sublethal impacts occurring over a larger area.

Non-OCS Leasing Impacts

Although lease stipulations prohibit bottom-disturbing activities for OCS-related construction, these stipulations do not apply to non-OCS-related activity. Severe and permanent physical damage may occur to pinnacle features and the associated live bottoms as a result of non-OCS activities. It is assumed those biota associated with live bottoms of the CPA are well adapted to natural disturbances such as turbidity and storms; however, human disturbance could cause severe damage to live-bottom biota, possibly leading to changes of physical integrity, species diversity, or biological productivity. If such events were to occur, recovery to pre-impact conditions could take as much as 10 years (Fucik et al., 1984).

Natural events such as storms, extreme weather, and fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms) may impact live-bottom communities. Because of the depth of the Pinnacle Trend environment, waves seldom have a direct influence. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments (Brooks, 1991; CSA, 1992b). These forces are not expected to be strong enough to cause direct physical damage to organisms living on the features. Rather, currents are created by the wave action that can resuspend sediments to produce added turbidity and sedimentation (Brooks, 1991; CSA, 1992b). The animals in this region are well-adapted to the effects common to this frequently turbid environment (Gittings et al., 1992a).

Recreational boating, fishing, and import tankering may severely impact live-bottom communities. Ships anchoring near major shipping fairways of the CPA, on occasion, may impact sensitive areas located near these fairways. Numerous fishermen also take advantage of the resources of the region and may anchor at hard-bottom locations to fish. Much of the fishing on these habitats uses bottom fishing gear that may damage benthic organisms or may snag on the reefs and be lost. Such gear, particularly lines of varying thickness, can cut into the tissues of many benthic organisms during storm movement of bottom waters.

Damage resulting from commercial fishing, especially bottom trawling, may have a severe impact on hard-bottom benthic communities. Bottom trawling in the Gulf of Mexico primarily targets shrimp from nearshore waters to depths of approximately 90 m (300 ft) (NRC, 2002). Although trawlers would not target areas with pinnacles as fishing ground, since pinnacles may tangle with gear, accidental instances of trawling may occur near or over pinnacles, resulting in community damage. Reports indicate that bottom trawling activity on hard-bottom substrates can overturn boulders and destroy epifaunal organisms (Freese et al., 1999). Large emergent sponges and anthozoans may be particularly vulnerable to trawling activity, as these organisms grow above the substrate and can be caught and removed by trawling activity (Freese et al., 1999). Recovery rates of corals and coralline algae may take decades to centuries and depend on the extent of the impact, frequency of disturbance, other natural changes that occur to the habitat, and the organism's life history (NRC, 2002).

Summary and Conclusion

Non-OCS activities that may occur in the vicinity of the pinnacle communities include recreational boating and fishing, import tankering, fishing and trawling, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions. These activities could cause damage to the pinnacle communities. Ships using fairways in the vicinity of pinnacles anchor in the general area of pinnacles on occasion, and numerous fishermen take advantage of the resources of regional bottoms. These activities could lead to instances of severe and permanent physical damage to individual formations. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments (Brooks, 1991; CSA, 1992b). Because of the depth of the Pinnacle Trend area, these forces are not expected to be strong enough to cause direct physical damage to organisms living on the reefs.

Possible impacts from routine activities of OCS oil and gas operations include anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, and discharges of produced waters. In addition, accidental subsea oil spills, or blowouts associated with OCS activities can cause damage to pinnacle communities. Long-term OCS activities are not expected to adversely impact the live-bottom environment because these impact-producing factors are restrained by the continued implementation of the lease stipulation and site-specific mitigations. The inclusion of the Live Bottom (Pinnacle Trend) Stipulation would preclude the occurrence of physical damage, the most potentially damaging of these activities. The impacts to the live bottoms are judged to be infrequent because of the small number of operations in the vicinity of pinnacles and the distance from the habitat. The impact to the live/hard-bottom resource as a whole is expected to be minimal because of primarily localized impacts.

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals should be minimized because of the proposed Live Bottom (Pinnacle Trend) Stipulation and the dilution of discharges and resuspended sediments in the area. Potential impacts from discharges would be further reduced by USEPA discharge regulations and permit restrictions.

The incremental contribution of a CPA proposed action to the cumulative impact is expected to be slight, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts should be restricted by the implementation of the Live Bottom (Pinnacle Trend) Stipulation, site-specific stipulations, the depths of the features, the currents in the live-bottom area, and the distance of pinnacle habitats from the source of impact.

4.2.1.6.2. Live Bottoms (Low Relief)

Live bottoms of various types are present in many locations on the Mississippi-Alabama Shelf, as well as on the West Florida Shelf **(Figure 4-42**). None of the blocks with live-bottom (low-relief) habitat would be offered for lease; however, several live-bottom (low-relief) areas are adjacent to blocks that would be offered for lease under a CPA proposed action (**Figure 4-42**). Therefore, an analysis of potential impacts is being included in this EIS. The analysis includes a summary of new information and the description of the biology of live-bottom (low relief) areas.

The Live Bottom (Low Relief) Stipulation implemented by BOEM protects biological resources of live-bottom areas from potential impacts by oil and gas activities to a depth of 100 m (328 ft) in the EPA and a small northeastern portion of the CPA. The Live Bottom (Low Relief) Stipulation defines low-relief areas as "seagrass communities, areas that contain biological assemblages consisting of sessile invertebrates living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; and areas where a hard substrate and vertical relief may favor the accumulation of turtles, fish, or other fauna" (USDOI, MMS, 2009a). Sessile invertebrates may include sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals. The BOEM recommends the application of the Live Bottom (Low Relief) Stipulation for a proposed action within one of the OCS lease blocks that has low-relief features.

Because no blocks with Live Bottom (Low Relief) features would be leased as part of the current lease sale, the Live Bottom (Low Relief) Stipulation would not be applied to a lease. However, routine environmental reviews for areas of the CPA that are for lease and adjacent to Live Bottom (Low Relief) blocks would reveal any potential sites of live-bottom habitat that may overlap with planned seafloor impacts. Survey information must cover the entire area of planned seafloor impacts, including blocks adjacent to the lease if needed. During the review process, seafloor surveys would be analyzed to determine that all activity is adequately distanced from sensitive benthic features. Particular attention would be paid to making sure that anchor spreads completely avoid all hard bottoms. Therefore, any activity that occurs in an area adjacent to a live-bottom (low-relief) block would be reviewed to make sure that any routine activity (discharges from drilling or production, infrastructure emplacement, or anchoring for infrastructure emplacement) does not impact organisms in a protected block. These BOEM site-specific reviews would minimize potential impacts on the biota of live bottoms from operations resulting from a CPA proposed action. All proposed OCS-related activities are submitted to BOEM for evaluation and approval. Exploration plans, development plans, and pipeline applications would be thoroughly reviewed to ensure that all bottom disturbances would avoid impacting sensitive live bottoms.

4.2.1.6.2.1. Description of the Affected Environment

Live-bottom (low-relief) habitats are found on the continental shelf in both the CPA and EPA. The low-relief live bottoms in the CPA are only found in the northeastern portion of the planning area, while the EPA has a much more widely dispersed live-bottom (low-relief) habitat (**Figure 4-42**). The BOEM applies the Live Bottom (Low Relief) Stipulation to lease blocks that are within these described areas within waters 100 m (328 ft) or less. Live-bottom (low-relief) blocks are not offered for lease under a CPA proposed action.

Ecology of Inner- and Middle-Shelf Live Bottoms of the Mississippi-Alabama Shelf

Nearshore hard-bottom areas are located on the Mississippi-Alabama shelf in 18-40 m (60-130 ft) of water (**Figure 4-42**). A fine-grained quartz sand sheet covers most of the Mississippi-Alabama Shelf; however, numerous hard bottoms that are formed of sedimentary rock occur in the CPA off the Mississippi River Delta and seaward of the Chandeleur Islands (Schroeder, 2000). Sediments across the area east of the Mississippi River transition from the silt/clay of the delta to quartzose riverine sands of the eastern rivers, to the carbonate Florida platform characterized by carbonate sands and generally clear waters (east of De Soto Canyon). Low-relief, hard-bottom features are located on the inner and middle Mississippi-Alabama shelf. These features include isolated low-relief, reef-like structures; rubble fields; low-relief flat rocks (e.g., 6 m long and 60 cm thick; 20 ft long and 2 ft thick); limestone ledges (e.g., 4 m [13 ft] high); rocky outcrops off Mobile Bay (18- to 40-m [59- to 131-ft] depth range; 5 m wide and 2 m high; 16 ft wide and 7 ft high); and clustered reefs (e.g., tens of meters across and 3 m [10 ft] high) (Schroeder et al., 1988; Schroeder, 2000). Hard-bottom features on the Mississippi-Alabama-Florida Shelf (MAFLA) typically provide reef habitat for tropical organisms, including sessile epifauna (soft corals, nonreef-building hard corals, sponges, bryozoans, crinoids) and fish; these areas are typically of low relief (<1 m; 3 ft) (Thompson et al., 1999).

Four types of rock formations that form the hard-bottom areas are described by Schroeder et al. (1988).

- massive to nodular sideritic sandstones and mudstones, which are scattered on the central and western portions of the shelf;
- slabby-aragonite-cemented coquina and sandstone rubble associated with storm related ridges of shell and sand on the central shelf;
- dolomitic sandstone in small irregular outcrops; and
- calcite cemented algal calcirudite occurring in reef-like knobs on the southeastern shelf.

Schroeder et al. (1988 and 1989) described four live-bottom areas west of De Soto Canyon: Southeast Bank, Southwest Rock, Big Rock/Trysler Grounds, and features at the 17 Fathom Hole.

- The Southeast Bank is a rock rubble field site in 21-27 m (69-87 ft) of water-bearing encrusting epifauna (mostly the soft corals *Leptogorgia virgulata* and *Lophogorgia hebes*).
- The Southwest Rock area is made of two rocks that are 10 m (33 ft) apart. The larger of the two is 7-9 m (23-30 ft) wide and 1-1.5 m (3-5 ft) high. The smaller rock is 1.5-3.5 m (5-11 ft) wide, but it is almost level with the surrounding rubble substrate.
- The Big Rock/Trysler Grounds are 5 m (16 ft) tall mound-like structures of rock rubble found in 30-35 m (98-115 ft) of water.
- The features at the 17 Fathom Hole are reef-like and mound-like. One reef-like feature is 100 m (328 ft) long, 35 m (115 ft) wide, and 2 m (7 ft) high. A mound-like feature is made of rock rubble, covers a 300 m^2 (3,228 ft^2) area, and rises 2 m (7 ft) above the seafloor.

The soft corals *Leptogorgia virgulata* and *Lophogorgia hebes* were the most frequently encountered encrusting organisms amongst inner- and mid-shelf hard bottoms. Other biotic cover, not as common as soft corals, was made of hydroids and bryozoans (Schroeder et al., 1988 and 1989). Brooks (1991) found shallow-water hard bottoms off Mobile Bay that support living algae communities. The 40-Fathom

Isobath area is located 24 km (15 mi) northeast of the Pinnacle Trend area (described in **Chapter 4.2.1.6.1.1**) in water depths of approximately 75 m (245 ft). This area consists of topographic features with up to 9 m (30 ft) of relief that are mound-like, pinnacle-like, or ridge-like in form (Schroeder et al., 1988 and 1989).

Shipp and Hopkins (1978) found a hard-bottom area of large, rectangular limestone blocks rising up to 10 m (33 ft) off the seafloor near the head of De Soto Canyon in 55 m (180 ft) of water (**Figure 4-43**). Live cover included sponges, nonreef-building hard coral (*Oculina diffusa*), soft corals (*Lophogorgia cardinalis* and *L. hebes*), and an antipatharian (*Antipathes* sp.). A diverse and abundant tropical fish community was associated with the hard bottom. Benson et al. (1997) found another important hard-bottom community, the "De Soto Canyon rim feature," on the western edge of the canyon head.

Ecology of Inner- and Middle-Shelf Live Bottoms of the West Florida Shelf

A majority of live-bottom (low-relief) habitats in the GOM is found on the West Florida Shelf (**Figure 4-42**). These areas are not offered for lease under a CPA proposed action, but they are considered in this EIS because accidental releases of oil could affect habitats in the area. The BOEM has designated blocks on the West Florida Shelf out to 100-m (328-ft) depth as Live Bottom (Low Relief) Stipulation blocks **(Figure 4-42)** because live-bottom communities are widely scattered across the West Florida Shelf. The shelf is a relatively flat table of carbonate (karst limestone geology) that is largely covered with carbonate sand sheets. In many places, the sand moves around due to seasonal storms, forming ephemeral (temporary) patches of sand interspersed with exposed hard bottom. Various species of sessile (attached) reef fauna and flora grow on the exposed hard grounds. Some species such as sea whips and other gorgonians are tall enough to survive sand movement and accretion.

In addition to the widely distributed hard-bottom areas, there are also permanent areas of hard bottom that have greater relief than the exposed hard-bottom habitat. Three areas are NMFS-designated HAPC's on the West Florida Shelf: The Madison-Swanson Marine Reserve; The Florida Middle Ground; and Pulley Ridge. Other higher relief live-bottom areas, including the Steamboat Lumps Special Management Area and the Sticky Ground Mounds, are also important habitats on the West Florida Shelf. The above-named, live-bottom habitats are relic reef formations that were "drowned" with sea-level rise. Many of the formations have deep reef communities with sponges, sea fans, black corals, scattered *Oculina* corals, echinoderms, and crabs. In addition, habitats with formations that are closer to the water surface have some hermatypic (reef-building) corals.

Recent Invasive Species Concerns

Two invasive species have been reported in the Gulf of Mexico: the orange cup coral (*Tubastraea coccinea*) and the lionfish (*Pterois volitans/miles*). According to Executive Order 13112, an invasive species is defined as an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. *Tubastraea coccinea*, which is reported on many oil and gas platforms in the northern Gulf of Mexico, has been reported on several artificial reefs off the Florida coast (Fenner and Banks, 2004). It was first reported in 2001 and believed to have been introduced on hulls of ships used for artificial reefs (Fenner and Banks, 2004). The lionfish was reported off the coasts of Florida, Alabama, and Louisiana in 2010 (USDOI, GS, 2010b). It has also recently been reported in the southern Gulf of Mexico (Aguilar-Perera and Tuz-Sulub, 2010). Specific sightings were noted at several artificial reefs and oil and gas platforms in the CPA (USDOI, GS, 2010b).

Proposed Candidates for Threatened and Endangered Species

Elkhorn coral (*Acropora palmata*), which was listed as "threatened" in 2006 and is protected under the ESA, has been documented in patch reefs off Florida. In 2009, a petition was submitted to NMFS by the Center for Biological Diversity to list 82 additional species of coral under the ESA (USDOC, NOAA, 2010f). Those 82 "candidate species" are currently under review by NMFS. Some of the "candidate species" are found in the Gulf of Mexico, including *Montastraea annularis*, *Montastraea faveolata*, *Montastraea franksi*. Once NMFS has reviewed the candidate species, a decision would be made as to whether each species warrants listing under the ESA or not. If these species are listed, they would receive protection under the ESA.

Essential Fish Habitat

The NMFS has designated essential fish habitat (EFH) for coral species within the Florida Middle Grounds, southwest tip of the Florida reef tract, and in predominant patchy hard bottom offshore of Florida from approximately Crystal River south to the Keys that are managed under FMP's (USDOC, NMFS, 2010a). The EFH is defined as

> "**waters**—aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; **substrate**—sediment, hard bottom, structures underlying the waters, and associated biological communities; **necessary**—the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and **spawning, breeding, feeding, or growth to maturity**—stages representing a species' full life cycle" (USDOC, NMFS, 2010a).

Groups of coral protected under the Coral and Coral Reef FMP include octocorals, fire corals, stinging corals, stony corals, black corals, and deepwater corals (GMFMC and SAFMC, 1982). The EFH for coral in the Gulf of Mexico is designated for all life stages. The Magnuson-Stevens Act requires Federal agencies to consult with NMFS on actions that are to be federally permitted, funded, or undertaken that may have an adverse effect on EFH. Adverse effects are defined as "any impact that reduces quality and/or quantity of EFH . . . [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction of species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (USDOC, NMFS, 2010a).

Habitat Areas of Particular Concern

The NMFS has designated habitat areas of particular concern (HAPC) within identified EFH. The HAPC provide important habitat for federally managed fish species and are areas for conservation priorities. Areas designated as hard-bottom HAPC in the CPA are Florida Middle Grounds, Madison-Swanson Marine Reserve, Tortugas North and South Ecological Reserves, and Pulley Ridge (Dale and Santos, 2006; GMFMC, 2005). Elkhorn coral, a federally listed threatened species, is found in patch reefs off the Florida Keys and Florida reef tract (GMFMC, 2005; USDOC, NOAA, 2011f). The Florida patch reefs are one of four NMFS designated critical habitats for elkhorn coral (USDOC, NOAA, 2011f).

Baseline Conditions following the *Deepwater Horizon* Event

Extensive literature, Internet, and database searches have been conducted for results of scientific data at low-relief, hard-bottom features following the DWH event. Although many research cruises have occurred, very few reports containing data have been released as of the publication of this EIS. Descriptions of studies in progress are discussed, and any results indicated are included below. A few early data releases have indicated that baseline conditions near the well may have been altered; however, impacts to hard-bottom areas farther from the well are still unknown.

The potential oiling footprint as reported through NOAA's Environmental Response Management Application (ERMA) posted on the GeoPlatform.gov website indicated that oil was recorded in surface waters above hard-bottom features in the northern Gulf of Mexico (USDOC, NOAA, 2011b). The oil footprint extended from approximately Lake Charles, Louisiana, to Panama City, Florida. The oil was distributed in patches and ribbons rather than a continuous blanket of petroleum and migrated over time so that it did not have a continuous cover over the entire area for the duration of the spill (USDOC, NOAA, 2011b). The relief of the hard-bottom features do not rise much above the seafloor and are, therefore, far below the sea surface, which helps to protect the epibenthic species from physical oil contact because their crests are deeper than the physical mixing ability of surface oil (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Thompson et al., 1999; Schroeder et al., 1988; Schroeder, 2000). Small, low-relief features in shallow water near the coast at the northern extent of the Gulf of Mexico may have had a greater chance of oil exposure than the deeper features. However, the greatest area of low-relief, hard-bottom features occurs off the western Florida coast, to the south and east of the footprint of oil coverage.

The DWH event may have impacted some hard-bottom features located much closer to the well on the Mississippi-Alabama shelf than the live-bottom (low-relief) features. Oil was detected in the CPA in a subsurface plume in water depths between 1,100 and 1,300 m (3,609 and 4,265 ft) and moving southwest along those depth contours (OSAT, 2010). Epibenthic organisms that protrude above the sediment may have been exposed to oil droplets in the water column or at the seafloor/water interface near the subsea plume. The strata where the subsea plume occurred were a place that scientists recorded visible impact to benthic organisms. A recent report documents damage to a deepwater (1,400 m; 4,593 ft) coral (gorgonian) community 11 km (7 mi) to the southwest of the well, which is the direction of travel of the subsea oil plume. The BOEMRE and NOAA dedicated part of their collaborative Lophelia II Expedition: Oil Seeps and Deep Reefs, to investigating damage to deep corals as a result of the DWH event. Results are still pending but it appears that a coral community in the CPA about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged and that the damage may have been the result of contact with the subsea oil plume (Fisher, 2010a; USDOI, BOEMRE, 2010j). See **Chapter 4.2.1.10** for a detailed description of the affected deepwater coral community.

Water and sediment samples collected during and after the spill were analyzed as part of the OSAT (2010) report. A handful of samples collected off the Gulf Coast did reveal some PAH's as a result of the DWH event, although those samples were not collected in the vicinity of protected hard–bottom, low-relief features (OSAT, 2010). There were 6 water samples out of 481 collected that exceeded the USEPA chronic toxicity benchmarks for PAH in the offshore waters (>3 nmi [3.5 mi; 5.6 km] offshore to the 200-m [656-ft] bathymetric contour), all of which occurred within 1 m (3 ft) of the water surface (OSAT, 2010). There were 63 water samples out of 3,612 collected from deep water (>200 m; 656 ft) that were consistent with MC252 oil and that exceeded the USEPA aquatic life benchmarks for PAH (OSAT, 2010). Exceedances occurred near the water surface or in the southwest traveling deepwater plume within 70 km (43 mi) of the well. Oil detected in the subsurface plume was between 1,100 and 1,300 m (3,609 and 4,265 ft) and moving southwest along those depth contours (OSAT, 2010), which is deeper than and in the opposite direction of the low–relief, hard-bottom features on the continental shelf. The oil in the deepwater plume was carried by deepwater currents, which do not transit up onto the continental shelf (Pond and Pickard, 1983; Inoue et al., 2008), thereby protecting the low-relief features. No sediment samples collected offshore (>3 nmi [3.5 mi; 5.6 km] offshore to the 200-m [656-ft] depth contour) and seven sediment samples collected in deep water (>200 m; 656 ft) exceeded the USEPA aquatic life benchmarks for PAH exposure (OSAT, 2010). All chronic aquatic life benchmark exceedances in the sediment occurred within 3 km (2 mi) of the well and samples fell to background levels at a distance of 10 km (6 mi) from the well (OSAT, 2010). Dispersants were also detected in waters off Louisiana but were below USEPA benchmarks of chronic toxicity. No dispersants were detected in sediment on the Gulf floor (OSAT, 2010). The low-relief features, therefore, are not expected to have been acutely impacted by PAH in the water column or sediment, as they are located much farther from the well than measured benchmark exceedances. However, chronic impacts may have occurred as a result of low-level or long-term exposure to dispersed, dissolved, or neutrally buoyant oil droplets in the water column.

The Macondo oil weathered as it traveled to the sea surface, as it floated on the sea surface, and as it traveled in the subsea plume, where in each case it became depleted in lower molecular weight PAH's (which are the most acutely toxic components) (Brown et al., 2010; Eisler, 1987). The longer the oil spent in the water column or at the sea surface, the more diluted and weathered it became (Lehr et al., 2010). Chronic impacts that may result to species that came in contact with the diluted and weathered oil may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment (Kushmaro et al., 1997; Loya, 1975 and 1976b; Rinkevich and Loya, 1977). These types of possible impacts may be investigated in future studies if deemed necessary by NRDA. It should be noted that it may be difficult to distinguish between possible low-level impacts to invertebrates as a result of exposure to DWH oil and impacts from numerous natural seeps in the CPA that are constantly releasing oil into the water (MacDonald, 2002).

Harbor Branch Oceanographic Institute and the NOAA Cooperative Institute for Ocean Exploration, Research, and Technology conducted the Florida Shelf-Edge Expedition (FLoSEE) following the DWH event from July 9 to August 9, 2010. The expedition focused on the following: (1) the assessment and documentation of deepwater coral reefs, shelf-edge mesophotic reefs, and hard-bottom essential fish habitat; (2) stress responses of corals and other marine invertebrates exposed to oil and chemical dispersants; (3) assessment of zooplankton and linkages between pelagic and benthic ecosystems; (4) chemical analysis of sessile benthic taxa and biomedical resources; and (5) education and outreach (Reed and Rogers, 2011). Survey sites along the east, south, and west Florida shelf and slope were partially selected based on the path of the oil plume. Particular sites of interest included Miami Terrace, Pourtales Terrace, Tortugas Ecological Reserve, Florida Keys National Marine Sanctuary, Pulley Ridge, Naples sinkhole, Lophelia Reefs, Sticky Grounds, Florida Middle Grounds, and Madison-Swanson Marine Protection Area. Videotape and photographs were taken from a submersible and specimens were collected and catalogued.

Once more data are released, we will have a better understanding of the measured impacts and possible long-term effects of the DWH event. Limited data are currently available on potential impacts of the DWH event on low-relief features in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to low-relief features. The BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives. Relevant data on the status of low-relief features after the DWH event, however, may take years to acquire and analyze. Much of this data is being developed through the NRDA process, which may take years to complete. Little data from the NRDA process have been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In the place of this incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches. The BOEM's case-by-case seafloor review of areas where bottom-disturbing activities are proposed for OCS-petroleum production, however, would serve to protect sensitive habitat from accidental impacts from oil and gas production, such as oil spills, by distancing production from the protected habitat. Details of how the site-specific reviews protect hard-bottom features in the Gulf of Mexico from routine and accidental impacts of petroleum production are discussed below.

4.2.1.6.2.2. Impacts of Routine Events

Background/Introduction

The Live Bottom (Low Relief) Stipulation (described in NTL 2009-G39 [USDOI, MMS, 2009a]) protection covers lease blocks that include water depths <100 m (328 ft) in the EPA and a portion of the northeastern CPA that was previously part of the EPA (**Figure 4-42**). Blocks subject to the Live Bottom (Low Relief) Stipulation, including those in the CPA, are not included in the area to be offered in a CPA proposed action; therefore, the stipulation would not apply to a CPA proposed action. No CPA lease sales since the 1980's have included blocks in areas where this stipulation applies. However, CPA blocks adjacent to this area are included in a CPA proposed action.

Although the Live Bottom (Low Relief) Stipulation would not be applied to a CPA lease sale (because live-bottom [low-relief] blocks are not included in a CPA lease sale), BOEM will still be conducting reviews of proposed OCS activities so that any live bottoms that could be impacted by proposed activity are protected. The case-by-case reviews are designed to prevent drilling activities and anchor emplacement (the major potential impacting factors on these live bottoms resulting from offshore oil and gas activities) from damaging the low-relief features. Both exploration and development plans will be reviewed on a case-by-case basis to determine whether a proposed operation could impact a low-relief area. If it is determined from site-specific information derived from BOEM studies, published information from other research programs, geohazards survey information, or another source that the operation would impact a low-relief area, the operator may be required to relocate the proposed operation.

Since the blocks covered by the Live Bottom (Low Relief) Stipulation are outside the area to be offered in a CPA proposed action, only those blocks adjacent to a CPA proposed action in the northeastern portion of the CPA could be affected by routine impacts (**Figure 4-42)**. The impact analysis presented below is for routine activities associated with a CPA proposed action.

A number of routine OCS-related factors may cause adverse impacts on the live-bottom communities and features. Damage caused by anchoring, infrastructure and pipeline emplacement, infrastructure removal, blowouts, drilling discharges, and produced-water discharges can cause mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible. Impacts from accidental events, such as oil spills and blowouts are discussed in **Chapter 4.2.1.6.2.3**.

Construction Impacts on Low-Relief Features

Anchoring may damage lush biological communities or the structure of the live-bottom features themselves, which attract fish and other mobile marine organisms. Anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels greatly disturb areas of the seafloor and are the greatest threats associated with the routine activities of a CPA proposed action to live-bottom areas at these depths. The size of the affected area would depend on water depth, anchor and chain sizes, chain length, method of placement, wind, and current. Anchor damage may result in the crushing and breaking of hard bottoms and associated communities. It may also result in community alteration through reduced or altered substrate cover, loss of sensitive species, and a reduction in coral cover in heavily damaged areas (Dinsdale and Harriott, 2004). Anchoring often destroys a wide swath of habitat by the anchor being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to corals as a result of anchoring may take 10 or more years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). Nearby species on these hard-bottom habitats that disperse larvae short distances, such as solitary species (cup corals, octocorals, and hydrocorals), may recolonize areas more rapidly than slow-growing colonial forms that disperse larvae great distances (Lissner et al., 1991). Such anchoring damage, however, should be minimized on low-relief hard bottoms, as BOEM conducts site-specific reviews of OCS activity so that bottom disturbances are distanced from sensitive live-bottom habitat. Because only a few CPA blocks for lease are adjacent to live-bottom (low-relief) blocks (**Figure 4-42**), any damage from routine activity should only be possible if construction activities take place immediately adjacent to designated live-bottom (low-relief) areas (i.e., drilling a well inside, but at the edge of a bordering block, and having the anchor spread of the drilling vessel extend into a block that is designated as having live-bottom [low-relief] features).

Infrastructure emplacement and pipeline emplacement could result in suspended sediment plumes and sediment deposition on the seafloor. Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (approximately 2,000 metric tons [2,205 tons] for exploratory wells—900 metric tons [992 tons] of drilling fluid and 1,100 metric tons [1,213 tons] of cuttings—and slightly lower discharges for development wells) (Neff, 2005), potential impacts on biological resources of hard-bottom features should be expressly considered if drill sites occur in blocks adjacent to such features. Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants.

Although the Live Bottom (Low Relief) Stipulation requires that bottom-disturbing activities cause no impact to low-relief features, some cuttings from a nearby emplacement may reach the live-bottom features. Differences in the dispersal patterns for well cuttings and drilling muds result from differences in disposal methodology (surface disposal or bottom shunting). For example, well cuttings that are disposed of at the water's surface tend to disperse in the water column and are distributed widely over a large area at low concentrations (CSA, 2004b; NRC, 1983). On the other hand, cuttings that are shunted to the seafloor are concentrated over a smaller area in piles instead of being physically dispersed over wide areas (Neff, 2005).

The heaviest concentrations of surface-released well cuttings and drilling fluids have been reported within 100 m (328 ft) of wells and are shown to decrease beyond that distance (CSA, 2004b; Kennicutt et al., 1996). The cuttings rarely accumulate thicknesses >1 m (3 ft) immediately adjacent to the well; thicknesses are usually not higher than a few tens of centimeters (about 1 ft) in the GOM. They are usually distributed unevenly in gradients and in patches, often dependent on prevailing currents (CSA, 2004b). A gradient of deposition is generally limited to about 250 m (820 ft) from the well site, but it may reach up to 500 m (1,640 ft) from the well, depending on prevailing currents and surrounding environmental conditions (Kennicutt et al., 1996; CSA, 2004b). The source of cuttings released at the surface would be, at the closest, in blocks adjacent to live-bottom (low-relief) habitats. However, low-relief features could react negatively to drill cuttings if they do contact the habitat. For example, the ahermatypic (nonreef-building) coral, *Caryophyllia* sp., which may be found on some of these hard-bottom habitats, has displayed a significant dose-response relationship with sediment loading where densities of the species decreased with an increase in drilling mud particles (Hyland et al., 1994).

In order to protect live-bottom (low relief) features, BOEM conducts site-specific reviews of all planned wells and pipelines. If a hard-bottom feature is discovered during the review process, BOEM may require relocation of operations to avoid live-bottom areas. This review process prevents well drilling activities from occurring near sensitive live-bottom areas. Other mitigation may be imposed on an operator, such as bottom shunting of cuttings, to protect live-bottom areas from burial, including those of low relief. Also, the USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings to protect biological features. **Chapter 4.2.1.2** details the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. If cuttings and drilling fluids are transported to approved disposal sites, the live bottoms would be even further protected from sedimentation. Due to BOEM's site-specific review process and USEPA's discharge regulations, possible turbidity and smothering impacts of sessile invertebrates on hard-bottom features caused by drilling muds and cuttings are anticipated to be minimized.

Drilling fluid adhering to cuttings forms plumes that are rapidly dispersed on the OCS. Approximately 90 percent of the material discharged (cuttings and drilling fluid) settle rapidly to the seafloor, while 10 percent forms a plume of fine mud that drifts in the water column (Neff, 2005). Although drilling mud plumes may be visible 1 km (0.6 mi) from the discharge, rapid dilution of drilling mud plumes was reported within 6 m (20 ft) from the release point (Shinn et al., 1980; Hudson et al., 1982). Drilling muds and cuttings may be diluted 100 times at a distance of 10 m (33 ft) from the discharge and 1,000 times at a distance of 100 m (328 ft) from the discharge (Neff, 2005). Dilution continues with distance from the discharge point, and at 96 m (315 ft) from the release point, a plume was measured only a few milligrams/liter above background suspended sediment concentrations (Shinn et al., 1980). With consideration that drilling is not allowed on live-bottom habitats, that protective measures must be taken to avoid low-relief features, and that field measurements of suspended solids rapidly decline with distance from the source, turbidity impacts to live-bottom communities should be minimized.

Drilling mud concentrations at 6 m (20 ft) from the discharge were often less than those produced during storms or from boat wakes and, at 96 m (315 ft), they were less than suspended sediment concentrations measured on a windy day in coral reefs off Florida, and far below concentrations measured to cause physiological impacts to corals (Shinn et al., 1980; Thompson et al., 1980; Szmant-Froelich et al., 1981; Kendall et al., 1983). The toxic effects measured as a result of exposure to drilling mud are not caused by turbidity alone, but by the compounds in the drilling mud (Kendall et al., 1983). Extrapolation of data collected from bioassays indicates the no-effect concentration of drilling mud to be 3.99 ppm, which is above the average concentration of drilling mud measured in the water column 96 m (315 ft) from platforms (Kendall et al., 1983; Shinn et al., 1980). Based on those values, there should be no effects from drilling mud 96 m (315 ft) from a platform and possible limited effects at 6 m (20 ft) from the well.

There is little opportunity for drilling muds and cuttings to affect low-relief live bottoms. The low-relief, live-bottom habitats are mostly in the EPA, with some stretching westward into the edge of the CPA. Since the northeast portion of the CPA is not included in the area to be offered in a CPA proposed action, only activities on the northeast border of a CPA proposed action would be adjacent to some low-relief, live-bottom habitats. The Mississippi River flows into this area of the GOM, resulting in high levels of natural turbidity. This turbidity forms a gradient from the source with levels declining farther from the source. So, while muds and cuttings from a CPA proposed action could drift to the east, they will decline to background levels before reaching sensitive live-bottom habitats. The organisms in this area are tolerant of turbid environments (Rogers, 1990; Gittings et al., 1992a) and should not be impacted by the residual suspended sediment discharged during the drilling of a well. Many of the organisms that predominate in these communities also grow tall enough to withstand the sedimentation that results from their typical turbid environment or they have flexible structures that enable the passive removal of sediments (Gittings et al., 1992a). Mud that may reach these organisms can be removed by tentacle motion and mucus secretion (Shinn et al., 1980; Hudson and Robbin, 1980).

Recruitment studies conducted by Continental Shelf Associates (CSA) and Texas A&M University, Geochemical and Environmental Research Group (GERG); Marine Resources Research Institute (MRRI); and others suggest that recovery of hard-bottom communities following a disturbance will be slow (CSA and GERG, 2001; MRRI, 1984; Montagna and Holmberg, 2000). Epibiont recruitment showed relatively slow development of fouling community constituents on recruitment plates. Early colonizers are opportunistic epifauna, such as hydroids, bryozoans, barnacles, and bivalves that are tolerant of sediment loading (CSA and GERG, 2001; MRRI, 1984). Basically, only the earliest successional stages were observed after 1 year (MRRI, 1984) and after 27 months of exposure (CSA and GERG, 2001), and the epibiota typically associated with nearby hard-bottom features were rare on the plates (CSA and GERG, 2001). No sponges or corals had settled after 1 year (MRRI, 1984). Corals and sponges are known to display delayed recruitment and slow growth, and after 10 years corals and anemones were sparse on artificial reef habitats, and the community had still not reached "climax" state (MRRI, 1984).

It is not known whether the results of the recruitment studies would have differed if the substrate had consisted of exposed patches of natural hard bottom; however, because analysis of artificial reefs exposed for months to several years also indicates slow community development, it can be anticipated that hard-bottom communities take a long time to recruit and develop (MRRI, 1984). Although settling plates and artificial reefs may differ from natural reefs, they can help to indicate recruitment time in a defaunated area (MRRI, 1984).

Long-Term and Operational Impacts on Low-Relief Features

Drilling operations may impact live-bottom communities. Drilling operations in Puerto Rico have led to reduced coral cover out to 65 m (213 ft) from the well, probably as a result of cutting deposition (Hudson et al., 1982). Corals beyond this distance did not show reduced surface cover (Hudson et al., 1982). Live bottoms of low-relief features may experience some deposition of cuttings, especially if a well is within a few hundred meters of a live bottom. Impacts as a result of cuttings disposal may reach 100-200 m (328-656 ft) from a well (Montagna and Harper, 1996; Kennicutt et al., 1996). The BOEM case-by-case review of planned OCS activity protects hard-bottom features on the Gulf floor by requiring bottom-disturbing activity to be distanced from live-bottom features.

Impacts as a result of exposure to contaminants may occur to live-bottom organisms within 100-200 m (328-656 ft) of the well as a result of offshore oil and gas production (Montagna and Harper, 1996; Kennicutt et al., 1996; Hart et al., 1989; Kennicutt, 1995; CSA, 2004b). Sand content, metals, barium, inorganic carbon, and petroleum products have all been reported to be elevated near platforms (Kennicutt, 1995). Distribution of discharges tends to be patchy, have sharp gradients, and be directional (Kennicutt, 1995). The greatest impacts occur in low-energy environments where depositions may accumulate and not be redistributed (Neff, 2005; Kennicutt et al., 1996).

Elevated levels of barium, silver, cadmium, mercury, lead, and zinc were found out to 200 m (656 ft) from platforms and are likely a product of drilling muds and cuttings (Kennicutt et al., 1996; Hart et al., 1989; Chapman et al., 1991; CSA, 2004b). Metal concentrations in sediments near gas platforms (approximately out to 100 m [328 ft]) have been reported above those that may cause deleterious biological effects. The impacts are believed to be a result of metal toxicity originating from drill cuttings during the installation of the well, which remain in the sediment (Montagna and Harper, 1996; Carr et al., 1996). Hydrocarbon enrichment has been reported within 25 m (80 ft) and out to 200 m (656 ft) of petroleum platforms, and the concentrations decreased with distance from the platforms (Hart et al., 1989; Chapman et al., 1991; Kennicutt, 1995; Kennicutt et al., 1996). The concentrations of PAH's in the sediment surrounding platforms, however, were below the biological thresholds for marine organisms and appeared to have little effect on benthic organisms (Hart et al., 1989; McDonald et al., 1996; Kennicutt et al., 1996). If any of the drill cuttings reach live-bottom features, impacts from metal or hydrocarbon exposure may occur. Although the literature does not report the impacts to gorgonians or soft corals as a result of exposure to contaminants in cuttings, infauna have shown effects including reduced fecundity, altered populations, and acute toxicity (Montagna and Harper, 1996; Carr et al., 1996; Kennicutt et al., 1996; Hart et al., 1989; Chapman et al., 1991; CSA, 2004b). Impacts to benthos would be reduced with distance from the discharge.

Produced waters are discharged at the water surface throughout the lifetime of the production platform and may contain hydrocarbons, trace metals, elemental sulfur, and radionuclides (Kendall and Rainey, 1991). Heavy metals enriched in the produced waters include cadmium, lead, iron, and barium (Trefry et al., 1995). Produced waters may impact both organisms attached to the production platform and benthic organisms in the sediment beneath the platform because the elements in the produced water may remain in the water column or attach to particles and settle to the seafloor (Burns et al., 1999). A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in **Chapter 4.2.1.2**.

Produced waters are rapidly diluted and impacts are generally only observed within proximity of the discharge point (Gittings et al., 1992a). Models have indicated that the vertical descent of a surface originating plume should be limited to the upper 50 m (164 ft) of the water column and maximum concentrations of surface plume water have been measured in the field between 8 and 12 m (26 and 39 ft) (Ray, 1998; Smith et al., 1994). Plumes have been measured to dilute 100 times within 10 m (33 ft) of the discharge and 1,000 times within 103 m (338 ft) of the discharge (Smith et al., 1994). Modeling exercises showed hydrocarbons to dilute 8,000 times within 1 km (0.6 mi) of a platform and constituents such as benzene and toluene to dilute 150,000 and 70,000 times, respectively, within that distance (Burns et al., 1999).

The less soluble fractions of the constituents in produced water associate with suspended particles and may sink (Burns et al., 1999). Particulate components were reported to fall out of suspension within 0.5-1 nmi (0.6-1.2 mi; 0.9-1.9 km) from the source outfall (Burns et al., 1999). The particulate fraction disperses widely with distance from the outfall and soluble components dissolve in the water column, leaving the larger, less bioavailable compounds on the settling material (Burns et al., 1999). Due to BOEM's policy, which does not allow bottom-disturbing activity to impact low-relief live bottoms and dispersion of particles in the water column, the particulate constituents of produced waters should not impact biological communities on these live bottoms (Burns et al., 1999).

Waterborne constituents of produced waters can influence biological activity at a greater distance from the platform than particulate components can (Osenberg et al., 1992). The waterborne fractions travel with currents; however, data suggest that these fractions remain in the surface layers of the water column (Burns et al., 1999). Modeling data for a platform in Australia indicated the plume to remain in the surface mixed layer (top 10 m; 33 ft) of the water column, which would protect low-relief, live-bottom features from produced water traveling with currents because most of these features are in water deeper than the surface mixed layer.

Acute effects caused by produced waters are likely only to occur within the mixing zone around the outfall (Holdway, 2002). Past evaluation of the bioaccumulation of offshore, produced-water discharges conducted by the Offshore Operators Committee (Ray, 1998) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Possibly toxic concentrations of produced water were reported 20 m (66 ft) from the discharge in both the sediment and the water column where elevated levels of hydrocarbons, lead, and barium occurred, but no impacts to marine organisms or sediment contamination were reported beyond 100 m (328 ft) of the discharge (Neff and Sauer, 1991; Trefry et al., 1995). Another study in Australia reported that the average total concentration of 20 aromatic hydrocarbons measured in the water column 20 m (66 ft) from a discharge was less than 0.5 μg/L (0.0005 mg/L or 0.0005 ppm) due to the rapid dispersion of the produced water plume (Terrens and Tait, 1996).

Compounds found in produced waters are not anticipated to bioaccumulate in marine organisms. A study conducted on two species of mollusk and five species of fish (Ray, 1998) found that naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals. Metals including: barium, cadmium, mercury, nickel, lead, and vanadium in the tissue of the clam, *Chama macerophylla*, and the oyster, *Crassostrea virginica*, collected within 10 m (33 ft) of discharge pipes on oil platforms were not statistically different from those located at reference stations (Trefry et al., 1995). Because high-molecular weight PAH's are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and they were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms (Ray, 1998).

Chronic effects including decreased fecundity; altered larval development, viability, and settlement; reduced recruitment; reduced growth; reduced photosynthesis by phytoplankton; reduced bacterial growth; alteration of community composition; and bioaccumulation of contaminants were reported for benthic organisms close to discharges and out to 1,000 m (3,281 ft) from the discharge (Holdway, 2002; Burns et al., 1999). Effects were greater closer to the discharges and responses varied by species. No other reports show effects out to this distance. High concentrations of produced waters may have a chronic effect on corals. The Australian coral, *Plesiastrea versipora*, when exposed to 25 percent and 50 percent produced water, had a significant decrease in zooxanthellae photosynthesis and often bleached (Jones and Heyward, 2003). Experiments using water accommodated fractions (WAF) of produced waters indicated that coral fertilization was reduced by 25 percent and metamorphosis was reduced by 98 percent at 0.0721 ppm total hydrocarbon (Negri and Heyward, 2000). The WAF, however, is based on a closed experimental system in equilibrium and may be artificially low for the Gulf of Mexico, which will not reach equilibrium with contaminants. The experimental value can be considered a conservative approach that would overestimate impacts if the entire Gulf were to come in equilibrium with oil inputs.

Produced waters may have some impact on live-bottom features, but BOEM's site-specific review of planned OCS activities and required distancing of activity from sensitive habitats should help to reduce these impacts. The greatest impacts are reported adjacent to the discharge and out to 20 m (66 ft) from the discharge, but they are substantially reduced less than 100 m (328 ft) from the discharge. Because only a few potential live-bottom (low-relief) areas are adjacent to the area to be offered in a CPA proposed action, produced waters are not expected to reach the sensitive habitats in concentrations that would produce negative effects. The distance between the habitat and the discharge would allow for dispersion of the produced waters, which occurs rapidly (King and McAllister, 1998), reducing the concentration of discharged material to which the live bottoms may be exposed. The USEPA general NPDES permit restrictions on the discharge of produced water would also limit the impacts on biological resources of live bottoms. The USEPA's general NPDES permit restrictions on the discharge of produced water requires the effluent concentration 100 m (328 ft) from the outfall to be less than the 7-day "no observable effect concentration" based on laboratory exposures (Smith et al., 1994). This would help to limit the impacts on biological resources of live-bottom features. Measurements taken from a platform in the Gulf of Mexico showed discharge to be diluted below the "no observable effect concentration" within 10 m (33 ft) of the discharge (Smith et al., 1994). Such low concentrations would be even farther diluted at greater distances from the well, limiting the impacts on biological resources of live bottoms.

Structure-Removal Impacts on Low-Relief Features

The impacts of structure removal on live-bottom benthic communities can include turbidity, sediment deposition, explosive shock-wave impacts, and loss of habitat. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity that could impact surrounding live-bottom environments. Suspended sediment may evoke physiological impacts in benthic organisms including "changes in respiration rate, . . . abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003). The higher the concentration of suspended sediment in the water column and the longer the sediment remains suspended, the greater the impact.

Sediment deposition that occurs in ahermatypic coral communities may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, and causing physical abrasion (Wilber et al., 2005). Corals may experience reduced coverage, changes in species diversity and dominance patterns, alterations in growth rates and forms, decreased calcification, increased production of mucus, lesions, reduced recruitment, and mortality (Torres et al., 2001; Telesnicki and Goldberg, 1995). Coral larvae settlement may be inhibited in areas where sediment has covered available substrate (Rogers, 1990; Goh and Lee, 2008).

Corals have some ability to rid themselves of sediment through mucus production and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995). Octocorals and gorgonians are more tolerant of sediment deposition than scleractinian corals, as they grow erect and are flexible, reducing sediment accumulation and allowing easy removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992a). Gorgonians, corals, and sponges on low-relief features have also been reported to protrude above accumulated sediment layers, and it is hypothesized that these organisms can resist burial by growing faster than the sediment accumulates over the hard substrate upon which they settle (Lissner et al., 1991).

The shock waves produced by explosive structure removals may also harm benthic biota. However, corals and other sessile invertebrates have a high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure-removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders, were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m (25 ft) away from the detonation of 135-kg (298-lb) charges in open water incurred a 5 percent mortality rate. Very few crabs died when exposed to 14-kg

(31-lb) charges in open water 46 m (150 ft) away from the explosions. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods."

Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock wave is significantly attenuated when explosives are buried, as opposed to detonation in the water column (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m (15 ft) below the seabed, as required by BSEE regulations, would further attenuate blast effects (Wright and Hopky, 1998).

Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf: Programmatic Environmental Assessment* (USDOI, MMS, 2005) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of BOEM's site-specific reviews in preventing platform emplacement in the most sensitive areas of the GOM. Impacts on the biotic communities, other than those on or directly associated with the platform, would be limited by the relatively small size of individual charges (normally 50 lb [27 kg] or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m (15 ft) below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive) (USDOI, MMS, 2005). Also, because the live-bottom (low-relief) areas are generally far from a CPA proposed action, adverse effects to live-bottom features should be prevented.

Infrastructure or pipeline removal would impact the communities that have colonized the structures, many of which may also be found on live-bottom features. Removal of the structure itself would result in the removal of the hard substrate and the associated encrusting community. The overall community would experience a reduction in species diversity (both epifaunal encrusting organisms and the fish and large invertebrates that fed on them) with the removal of the structure (Schroeder and Love, 2004). The epifaunal organisms attached to the platform would die once the platform is removed. However, the seafloor habitat would return to the original soft-bottom substrate that existed before the well was drilled.

Some structures may be converted to artificial reefs. If the rig stays in place, the hard substrate and encrusting communities would remain part of the benthic habitat. The diversity of the community would not change and associated finfish species would continue to graze on the encrusting organisms. The community would remain an active artificial reef. However, plugging of wells and other reef-in-place decommissioning activities would still impact benthic communities as discussed above, since all the steps for removal except final removal from the water would still occur.

Proposed Action Analysis

The Live Bottom (Low Relief) Stipulation covers lease blocks that include waters less than 100 m (328 ft) deep in the EPA and a northeastern portion of the CPA that was previously part of the EPA (**Figure 4-42**). Blocks subject to the Live Bottom (Low Relief) Stipulation, including those in the CPA, are not included in the area to be offered in a CPA proposed action. No lease sales since the 1980's have included blocks in areas where this stipulation applies. However, adjacent blocks in the CPA are included in the area to be offered in a CPA proposed action. For a CPA proposed action, 62-121 exploration, 78-152 development wells, and 28-54 production structures are projected for offshore Subareas C0-60 (between the coastline and 60 m [197 ft] of water). There are 24-46 exploration/delineation, 32-58 development wells, and 3-6 production structures projected for offshore Subareas C60-200 (between 60 and 200 m [197 and 656 ft] of water). Few, if any, of the wells or production structures would be located near live-bottom (low-relief) areas because the areas are not included in the area to be offered in a CPA proposed action. Low-relief features would incur few incidences of anchor damage from support vessels for the same reason. In addition, BOEM conducts project-specific reviews of planned activity and requires the activity to be distanced from any hard-bottom areas near the proposed activity. Thus, anchoring events are not expected to impact the resource. Accidental anchor impacts, however, could occur, with recovery taking a few to many years, depending on the severity (Fucik et al., 1984; Rogers and Garrison, 2001; Lissner et al., 1991).

Pipeline emplacement also has the potential to cause considerable disruption to the bottom sediments in the vicinity of the live bottoms (**Chapter 3.1.1.8.1**); however, BOEM's site-specific project review of the surrounding seafloor would restrict pipeline-laying activities as well as oil and gas activities in the vicinity of the low-relief communities. The actual effect of pipeline-laying activities on the biota of the low-relief communities would be restricted to the resuspension of sediments. Burial of pipelines is only required in water depths of 60 m (200 ft) or less. Therefore, only the shallowest live-bottom communities would be affected by the increased turbidity associated with pipeline burial. The laying of pipeline without burial produces much less resuspension of sediments. The project-specific seafloor reviews would help to minimize the impacts of pipeline-laying activities.

Summary and Conclusion

Oil and gas operations discharge drilling muds and cuttings that generate turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings near low-relief areas would not greatly impact the biota of the live bottoms because the biota surrounding the low-relief features in or near the CPA are adapted to turbid (nepheloid) conditions and high sedimentation rates associated with the outflow of the Mississippi River (Gittings et al., 1992a). Regional surface currents and water depth would largely dilute any effluent. Additional deposition and turbidity caused by a nearby well are not expected to adversely affect the low-relief environment because such drilling muds and cuttings would be dispersed upon discharge. Toxic impacts on benthos are limited to within 100-200 m (328-656 ft) of a well (Montagna and Harper, 1996; Kennicutt et al., 1996), and NPDES permit requirements limit discharge. The drilling of a well, therefore, could have localized impacts on the benthos near the well, which should be located away from live-bottom features according to BOEM policy, and additionally, impacts would be reduced with distance from the well.

The toxicity of produced waters has the potential to adversely impact the live-bottom organisms; however, as previously stated, many of the low-relief areas are not in the area to be offered in a CPA proposed action and BOEM's site-specific seafloor review prior to any bottom-disturbing activity would prevent the placement of oil and gas facilities upon (and consequently would prevent the discharge of produced water directly over) low-relief, live-bottom habitats. Produced waters also rapidly disperse and remain in the surface layers of the water column, far above the live-bottom features.

Platform removals have the potential to impact nearby habitats. As previously discussed, the platforms would not be constructed directly on low-relief areas because these areas are either not included in the area to be offered in a CPA proposed action or are protected by BOEM policy, distancing blasts from sensitive low-relief habitats. Benthic organisms on live bottoms should also have limited impact because they are resistant to blasts, tolerant of turbidity, can physically remove some suspended sediment, and may be located above or be tall enough to withstand limited sediment deposition. The BOEM site-specific seafloor review and required distancing of seafloor disturbance from live-bottom features would help to prevent smothering events. Since the live-bottom areas are either not included in the area to be offered in a CPA proposed action or are protected by BOEM policy, most of the potential impacts on live bottoms from bottom-disturbing activities (structure emplacement and removal) and operational discharges associated with a CPA proposed action would be prevented. Any contaminants that reach live-bottom features would be diluted from their original concentration; therefore, impacts that do occur should be sublethal.

4.2.1.6.2.3. Impacts of Accidental Events

Background/Introduction

The live-bottom (low-relief) features of the CPA sustaining sensitive offshore habitats are located in water depths of less than 100 m (328 ft) and are described in **Chapter 4.2.1.6.2.1**. **Chapter 2.4.1.3.2** contains a complete description and discussion of the proposed Live Bottom (Low Relief) Stipulation. Live bottoms (low relief) are defined in NTL 2009-G39, which describes the applicable lease stipulation effective on blocks in the EPA and several blocks in the northeast portion of the CPA (USDOI, MMS, 2009a). Note that none of those blocks are included in the area to be offered in a CPA proposed action (**Figure 4-42**). Therefore, oil and gas activities from a CPA proposed action do not coincide with the live-bottom (low-relief) habitats. However, some areas leased as a result of a CPA proposed action could be adjacent to the sensitive habitats at the extreme western edge of the habitat range. Disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of live-bottom features of the CPA.

A catastrophic events analysis is provided in **Appendix B**; nevertheless, the type and kind of expected impacts to low-relief features from a catastrophic event would be similar to those described below as impacts from accidental events.

Possible Modes of Exposure

Oil released to the environment as a result of an accidental event may impact live-bottom features in several ways. Oil may be physically mixed into the water column from the sea surface, be injected below the sea surface and travel with currents, be dispersed in the water column, or adhere to particles and sink to the seafloor. These scenarios and their possible impacts are discussed in the following sections.

An oil spill that occurs at the sea surface would result in a majority of the oil remaining at the sea surface. Lighter compounds in the oil would evaporate and some components of the oil may dissolve in the seawater. Evaporation removes the most toxic components of the oil, while dissolution may allow bioavailability of hydrocarbons to marine organisms for a brief period of time (Lewis and Aurand, 1997). The oil may also emulsify with water or adsorb to sediment particles and fall to the seafloor.

A spill that occurs below the sea surface (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would result in only a portion of the released oil rising to the sea surface. All known reserves in the Gulf of Mexico have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. As discussed in **Chapter 3.2.1.5.4**, oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column, surfacing almost directly over the source location, thus not impacting sensitive benthic communities. If the leak is deep in the water column and the oil is ejected under pressure, oil droplets may become entrained deep in the water column (Boehm and Fiest, 1982). The upward movement of the oil may be reduced if methane in the oil is dissolved into the water column at high underwater pressures, reducing the oil's buoyancy (Adcroft et al., 2010). Large oil droplets will rise to the sea surface, but the smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010). Oil droplets less than 100 μm (0.004 in) in diameter may remain in the water column for several months (Joint Analysis Group, 2010a).

Impacts that may occur to benthic communities on live-bottom features as a result of a spill would depend on the type of spill, distance from the spill, relief of the biological feature, and surrounding physical characteristics of the environment (e.g., turbidity). The BOEM case-by-case review of OCS-activity will help to prevent impacts to live-bottom habitats by distancing petroleum-producing activity from habitat. The distance requirements from the habitat, however, are based on routine production activity, and oil released during accidental events may reach the locations of live-bottom features. However, unless dispersants are used, spilled oil would not be expected to mix into the water column more than 10 m (33 ft) deep (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). As described above, a majority of the oil released from a spill would rise to the sea surface, therefore reducing impact to benthic communities by direct oil exposure. However, small droplets of oil that are entrained in the water column for extended periods of time may migrate onto live-bottom habitat. Although these small oil droplets will not sink themselves, they may attach to suspended particles in the water column and then be deposited on the seafloor (McAuliffe et al., 1975). Exposure to subsea plumes, dispersed oil, or sedimented oil may result in long-term impacts such as reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. These impacts are discussed in the following sections.

Surface Slicks and Physical Mixing

Surface oil slicks can spread over a large area; however, the majority of the slick is comprised of a very thin surface layer of oil moved by winds and currents (Lewis and Aurand, 1997). Oil spills have the potential to foul benthic communities and cause lethal or sublethal effects to organisms that the oil contacts as it is moved over the sea surface. Low-relief, hard-bottom features may rise up to 4 m (13 ft) from the seafloor (Schroeder et al., 1988; Schroeder, 2000). Live-bottom features more than 10 m (33 ft) below the sea surface would be protected from contact with oil from surface slicks (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002).

Field data collected at the Atlantic entrance to the Panama Canal 2 months after a tanker spill has shown that subtidal coral did not show measurable impacts from the oil spill, presumably because the coral was far enough below the surface oil and the oil did not contact the coral (Rützler and Sterrer, 1970). A similar result was reported from a Florida coral reef immediately following and 6 months after a tanker discharged oil nearby (Chan, 1977). The lack of acute toxicity was again attributed to the fact that the corals were completely submerged at the time of the spill and that calm conditions prevented the oil from mixing into the water column (Chan, 1977).

Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10 m (33 ft). Modeling exercises have indicated that oil may reach a depth of 20 m (66 ft). Yet at this depth, the spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Therefore, the depth of offshore live-bottom features below the sea surface should protect them from physical mixing of surface oil below the sea surface. Features in water depths shallower than 10 m (33 ft) would be more susceptible to oil impacts. However, nearshore low-relief live habitats are not located in lease blocks of a CPA proposed action, distancing them from potential activities. If dispersants are used, they would enable oil to mix into the water column and possibly impact organisms on the live-bottom features adjacent to a CPA proposed action. Dispersants are discussed later in this section.

Subsurface Plumes

A subsurface oil spill or plume could reach a live-bottom feature and would have the potential to damage the local biota contacted by oil. Such impacts on the biota may have severe and long-lasting consequences, including loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. Such subsurface plumes are not expected under normal conditions unless dispersants are used to cause oil to mix with the water.

Live-bottom (low-relief) features are protected from bottom-disturbing activity through site-specific seafloor reviews that require activity to be distanced from live bottoms. This buffer zone, in turn, results in petroleum-producing activities occurring away from low-relief features. In addition, live-bottom, low-relief lease areas are excluded from a CPA proposed action. The distancing of petroleum-producing activities from live-bottom features allows for several physical and biological changes to occur to the oil before it reaches sensitive benthic organisms. Oil becomes diluted as it physically mixes with the surrounding water. The longer and farther a subsea plume travels in the sea, the more dilute the oil will be (Vandermeulen, 1982; Tkalich and Chan, 2002). In addition, microbial degradation of the oil occurs in the water column, reducing toxicity (Hazen et al., 2010; McAuliffe et al., 1981b). Subsea oil plumes transported by currents may not travel nearly as far as surface oil slicks because some oil droplets may conglomerate and rise or may be blocked by fronts, as was observed in the southern Gulf of Mexico during the *Ixtoc* spill (Boehm and Fiest, 1982). Should any of the oil come in contact with adult sessile biota, effects would be primarily sublethal, as the oil may be diluted by physical and biological processes by the time it reaches the features. Low-level exposure impacts may vary from chronic to temporary, or even immeasurable.

Although the areas open for lease are distanced from a majority of the live-bottom (low-relief) features, it is possible that low levels of oil transported in subsea plumes may reach benthic features. Several studies have reported results for oil impacts on both hermatypic (reef-building) and ahermatypic (nonreef-building) corals, both of which can be found on live-bottom (low-relief) features. Although not all of the same species studied are present on low-relief, hard-bottom features, impacts are expected to be similar. For example, coral feeding activity may be reduced if it is exposed to low levels of oil. Experiments indicated that normal feeding activity of *Porites porites* and *Madracis asperula* were reduced when exposed to 50 ppm oil (Lewis, 1971). Tentacle pulsation of an octocoral, *Heteroxenia fuscescens*, has also been shown to decrease upon oil exposure, although recovery of normal pulsation was observed 96 hours after the coral was removed from the oil (Cohen et al., 1977). *Porites furcata* exposed to Marine Diesel and Bunker C oil reduced feeding and left their mouths open for much longer than normal (Reimer, 1975).

Direct oil contact may result in coral tissue damage. Coral exposed to sublethal concentrations of oil for 3 months revealed atrophy of muscle bundles and mucus cells (Peters et al., 1981). *Porites furcata* submersed in Bunker C oil for 1 minute resulted in 100 percent tissue death, although the effect took 114 days to occur (Reimer, 1975).

Reproductive ability may also be reduced if coral is exposed to oil. A hermatypic coral, *Stylophora pistillata*, and an octocoral, *Heteroxenia fuscescens*, neither of which are present in the Gulf of Mexico, but may show impacts similar to those that could occur in the Gulf, shed their larvae when exposed to oil (Loya and Rinkevich, 1979; Rinkevich and Loya, 1977; Cohen et al., 1977). Undeveloped larvae in the water column have a reduced chance of survival due to predation and oil exposure (Loya and Rinkevich, 1979), which would in turn reduce the ability of larval settlement and reef expansion or recovery. A similar expulsion of gametes may occur in species that have external fertilization (Loya and Rinkevich, 1979), such as those at the Flower Garden Banks (Gittings et al., 1992c), which may then reduce gamete survivorship due to oil exposure.

The overall ability of a coral colony to reproduce may be affected by oil exposure. Reefs of *Siderastrea siderea* that were oiled in a spill produced smaller gonads than unoiled reefs, which resulted in reproductive stress for the oiled reef (Guzmán and Holst, 1993). *Stylophora pistillata* reefs exposed to oil had fewer breeding colonies, reduced number of ovaria per polyp, and significantly reduced fecundity compared with unoiled reefs (Rinkevich and Loya, 1977). Impaired development of reproductive tissue has also been reported for other reef-building corals exposed to sublethal concentrations of oil (Peters et al., 1981). Larvae may not be able to settle on substrate impacted by oil. Field experiments on *Stylophora pistillata* showed reduced settlement rate of larvae on artificial substrates of oiled reefs compared with control reefs and lower settlement rates, with increasing concentrations of oil in test containers (Rinkevich and Loya, 1977). Impaired larval settlement as a result of oiled substrate may lead to slow recovery of a disturbed substrate (CSA and GERG, 2001; MRRI, 1984; Montagna and Holmberg, 2000). Additionally, deeper habitats have slower rates of settlement, growth, and community development, and recruitment rates are reportedly slow in some live-bottom habitats (Montagna and Holmberg, 2000; CSA and GERG, 2001). It is possible that corals may not recruit to an oiled substrate for 10 years (MRRI, 1984).

Any hermatypic corals present on shallower live-bottom habitats may experience photosynthetic and growth impacts. Oil exposure is believed to reduce photosynthesis and growth in corals; however, low-level exposures have produced counterintuitive and sometimes immeasurable results. Photosynthesis of the zooxanthellae in *Diplora strigosa* exposed to approximately 18-20 ppm crude oil for 8 hours was not measurably affected, although other experiments indicate that photosynthesis may be impaired at higher concentrations (Cook and Knap, 1983). A longer exposure (24 hours) of 20 mL/L oil markedly reduced photosynthesis in *Stylophora pistillata*; however, concentrations of 2.5 mL/L oil resulted in physiological stress that caused a measurable increase in photosynthesis as compared with controls (Rinkevich and Loya, 1983). Other impacts recorded include the degeneration and expulsion of photosynthetic zooxanthellae upon coral exposure to oil (Loya and Rinkevich, 1979; Peters et al., 1981). Long-term growth changes in *Diploria strigosa* that was exposed to oil concentrations up to 50 ppm for 6-24 hours did not show any measurably reduced growth in the following year (Dodge et al., 1984).

Corals exposed to subsea oil plumes may also incorporate petroleum hydrocarbons into their tissue. Records indicate that *Siderastrea siderea*, *Diploria strigosa*, *Montastrea annularis*, and *Heteroxenia fuscescens* have accumulated oil from the water column and incorporated petroleum hydrocarbons into their tissues (Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992; Cohen et al., 1977). Most of the petroleum hydrocarbons were incorporated into the coral tissues, not their mucus (Knap et al., 1982). However, hydrocarbon uptake may also modify lipid ratios of coral (Burns and Knap, 1989). If lipid ratios are modified, mucus synthesis may be impacted, adversely affecting coral ability to protect itself from oil through mucus production (Burns and Knap, 1989). While these species are not present in the live-bottom (low-relief) areas of the Gulf of Mexico, similar effects may occur in live-bottom species.

Sublethal effects, although often hard to measure, could be long lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature and diseases) (Cohen et al., 1977; Jackson et al., 1989; Loya, 1976a). Continued exposure to oil from resuspended contaminated sediments could also impact coral growth and recovery (Guzmán et al., 1994). Any repetitive or long-term oil exposure could inhibit coral larvae's ability to settle and grow, may damage coral reproductive systems, may cause acute toxicity to larvae, and may physically alter the reef interfering with larval settlement, all of which would reduce coral recruitment to an impacted area (Kushmaro et al., 1997; Loya, 1975 and 1976a; Rinkevich and Loya, 1977). Exposure of eggs and larvae to oil in the water column may reduce the success of a spawning event (Peters et al., 1997).

Dispersed Oil

Chemically-dispersed oil from a surface slick is not anticipated to result in lethal exposures to organisms on live-bottom features. The chemical dispersion of oil promotes the weathering process and increases the surface area available for bacterial biodegradation. It also allows surface oil to penetrate to greater depths than physical mixing would permit and the dispersed oil will generally remain below the water's surface (McAuliffe et al., 1981b; Lewis and Aurand, 1997). However, reports on dispersant usage on surface plumes indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing sedimented oil traveling to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997).

Field experiments designed to test dispersant use on oil spills reported dispersed oil concentrations between 1 and 3 ppm, 9 m (30 ft) below the sea surface, approximately 1 hour after treatment with dispersant (McAuliffe et al., 1981a and 1981b). Other studies indicated that dispersed oil concentrations were <1 ppm, 10 m (33 ft) below the sea surface (Lewis and Aurand, 1997). The biological impacts that may occur from dispersant usage are greatest within the first hour of application and occur primarily to organisms living near the water's surface (Guillen et al., 1999). The above data indicate that the mixing depth of dispersed oil is less than the depths of the crests of most live-bottom features offshore, greatly reducing the possibility of exposure to dispersed surface oil. Features nearshore, in less than 10 m (33 ft) of water would be more susceptible to oil contact if oil reaches the area, but they are also farther from a CPA proposed action; this reduces their chance of contact and, if contact did occur, the oil would have had more time to weather and biodegrade before contact.

Any dispersed surface oil that may reach the benthic communities of live-bottom features in the Gulf of Mexico would be expected to be at very low concentrations (less than 1 ppm) (McAuliffe et al., 1981a). Such concentrations would not be life threatening to larval or adult stages based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Dispersants that are used on oil below the sea surface can travel with currents through the water and may contact benthic organisms on the live-bottom features. If the oil spill occurs close enough to a live-bottom feature, the dispersed oil could be concentrated enough to harm the community. However, the longer the oil remains suspended in the water column traveling with currents, the more dispersed it will become, and the distance of the areas offered for a lease sale from these features increases the dispersion factors. Weathering will also be accelerated and biological toxicity reduced with distance from the source (McAuliffe et al., 1981b). Although the use of subsea dispersants is a new technique and very little data are available on dispersion rates, it is anticipated that any oil that could reach live-bottom features will be in low concentration based on surface slick dilution data (McAuliffe et al., 1981a; Lewis and Aurand, 1997). Impacts resulting from exposure to dispersed oil are generally anticipated to be sublethal.

The report of damage to deepwater corals on the continental slope (USDOI, BOEMRE, 2010j) as a result of exposure to oil from the DWH may have resulted from the use of dispersant at the source of the blowout. This situation was the first time dispersants were used subsea, and stratified density layers of water allowed the oil plume to remain at depth instead of dispersing into the water column (Joint Analysis Group, 2010a). It appears that a density-bounded plume eventually contacted the coral community. The use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis. For example, NOAA policy says that the application of dispersants must occur as far as possible from the Flower Garden Banks (Gittings, 2006). There is, however, no written policy for the application of dispersants near low-relief live bottoms. The BOEM considers it unlikely that concentrated dispersants would be applied near low-relief features, but the decision on how and where to use dispersants is outside of BOEM's control.

Sublethal impacts that may occur to coral and other invertebrates exposed to dispersed oil may include reduced feeding, reduced photosynthesis, reduced reproduction and growth, physical tissue damage, and altered behavior. Short-term, sublethal responses of *Diploria strigosa* were reported after exposure to dispersed oil at a concentration of 20 ppm for 24 hours (Knap et al., 1983; Wyers et al., 1986). Although concentrations in this experiment were higher than what is anticipated for dispersed oil at depth, effects included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, localized tissue rupture (Wyers et al., 1986), and a decline in tentacle expansion behavior (Knap et al., 1983). Normal behavior resumed within 2 hours to 7 days after exposure (Wyers et al., 1986; Knap et al., 1983). This coral, however, did not show indications of stress when exposed to 1 ppm and 5 ppm of dispersed oil for 24 hours (Wyers et al., 1986). *Diploria strigosa* exposed to dispersed oil (20:1, oil:dispersant) showed an 85 percent reduction in zooxanthellae photosynthesis after 8 hours of exposure to the mixture (Cook and Knap, 1983). However, the response was sublethal, as recovery occurred between 5 and 24 hours after exposure and return to clean seawater. Investigations 1 year after *Diploria strigosa* was exposed to concentrations of dispersed oil between 1 and 50 ppm for periods between 6 and 24 hours did not reveal any impacts to growth (Dodge et al., 1984; Knap et al., 1983). It should be noted, however, that subtle growth effects may have occurred but they were not measurable (Knap et al., 1983). This type of short-term exposure is what is anticipated to be possible if live bottom-associated organisms experience impacts from dispersed oil.

Historical studies indicate that dispersed oil appeared to be more toxic to coral species than oil or dispersant alone. The greater toxicity may be a result of an increased number of oil droplets, resulting in greater contact area between oil and water (Elgershuizen and De Kruijf, 1976). The dispersant causes a higher water soluble fraction of oil contacting the cell membranes of the coral (Elgershuizen and De Kruijf, 1976). The mucus produced by coral, however, can protect an organism from oil. Both hard and soft corals have the ability to produce mucus; mucus production has been shown to increase when corals are exposed to crude oil (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Dispersed oil, which has very small oil droplets, does not appear to adhere to coral mucus, and larger untreated oil droplets may become trapped by the mucus barrier (Knap, 1987; Wyers et al., 1986). However, entrapment of the larger oil droplets may increase long-term exposure to oil if the mucus is not shed in a timely manner (Knap, 1987; Bak and Elgershuizen, 1976).

More recent field studies did not reveal as great an impact of dispersants on corals as were indicated in historical toxicity tests (Yender and Michel, 2010). This difference in reported damage probably resulted from a more realistic application of dispersants in an open field system and because newer dispersants are less toxic than the older ones (Yender and Michel, 2010). Field studies have shown oil to be dispersed to the part per billion level minutes to hours after the dispersant application, which is orders of magnitude below the reasonable effects threshold of oil in the water column (20 ppm) measured in some studies (McAuliffe, 1987; Shigenaka, 2001).

Although dispersed oil may be toxic to corals during some exposure experiments (Shafir et al., 2007; Wyers et al., 1986; Cook and Knap, 1983), untreated oil may remain in the ecosystem for long periods of time, while dispersed oil does not (Baca et al., 2005; Ward et al., 2003). The time of year and surrounding ecosystem must be considered when determining if dispersants should be used. Dispersant usage may result in reduced or shorter term impacts to coral reefs; however, it may increase the impacts to other communities, such as mangroves (Ward et al., 2003). Therefore, dispersant usage may be more applicable offshore than in coastal areas where other species may be impacted as well. Dispersants also would probably not be approved during peak coral spawning periods (e.g., August-September for major reef-building species) (Gittings et al., 1992c and 1994) in order to limit the impacts of oil pollution on the near-surface portion of the water column.

Sedimented Oil (Oil Adsorbed to Sediment Particles)

Smaller suspended oil droplets could be carried to the seafloor as a result of oil droplets adhering to suspended particles in the water column. Smaller particles have a greater affinity for oil (Lewis and Aurand, 1997). Oil may also reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Oiled sediment that settles to the seafloor may affect organisms attached to live-bottom features. It is anticipated that the greatest amount of sedimented oil would occur close to the spill, with lesser concentrations farther from the source. Studies after a spill that occurred at the Chevron Main Pass Block 41C Platform in the northern Gulf of Mexico revealed that the highest concentrations of oil in the sediment were close to the platform and that the oil settled to the seafloor within 5-10 mi (8-16 km) of the spill site (McAuliffe et al., 1975). Therefore, if the spill occurs close to a live-bottom feature, the underlying benthic communities may be exposed to toxic hydrocarbons. However, because BOEM policy prohibits bottom-disturbing activity on low-relief, live-bottom features and the fact that they are not included in the area to be offered in a CPA proposed action, these hard-bottom communities should be distanced from the heaviest oiled sedimentation effects.

Some oiled particles may become widely dispersed as they travel with currents while they settle out of suspension. Settling rates are determined by size and weight of the particle, salinity, and turbulent mixing in the area (Poirier and Thiel, 1941; Bassin and Ichiye, 1977; Deleersnijder et al., 2006). Because particles will have different sinking rates, the oiled particles would be dispersed over a large area, most likely at sublethal or immeasurable levels. Studies conducted after the *Ixtoc* oil spill revealed that, although oil was measured on particles in the water column, measurable petroleum levels were not found in the underlying sediment (ERCO, 1982). Based on BOEMRE restrictions and the settling rates and behavior of sedimented oil, the majority of organisms that may be exposed to sedimented oil are anticipated to experience low-level concentrations.

Sublethal impacts to benthic organisms may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. Experiments have shown that the presence of oil on available substrate for larval coral settlement has inhibited larval metamorphosis and larval settlement (Kushmaro et al., 1997). Crude oil concentrations as low as 0.1 ppm on substrate upon which the coral larvae were to settle reduced larval metamorphosis occurrences by 50 percent after 8 days of exposure. Oil concentrations of 100 ppm on substrates only resulted in 3.3 percent of the test population metamorphosizing (Kushmaro et al., 1997). There was also an increased number of deformed polyps after metamorphosis due to oil exposure (Kushmaro et al., 1997). It is also possible that recurring exposure may occur to coral if sedimented oil is resuspended locally, possibly inhibiting coral growth and recovery in the affected areas (Guzmán et al., 1994). Oil stranded in sediment is reportedly persistent and does not weather much (Hua, 1999), so coral may be repeatedly exposed to elevated concentrations of oil.

Adult coral, however, may be able to protect itself from low concentrations of sedimented oil through mucus production. Coral mucus may not only act as a barrier to protect coral from the oil in the water column, it has been shown to aid in the removal of oiled sediment on coral surfaces (Bak and Elgershuizen, 1976). Coral may use a combination of increased mucus production and ciliary action to rid themselves of oiled sediment (Bak and Elgershuizen, 1976).

Blowout and Sedimentation

Oil or gas well blowouts are possible occurrences in the OCS. Benthic communities exposed to large amounts of resuspended sediments following a subsurface blowout could be subject to sediment suffocation, exposure to toxic contaminants, and reduced light. Should oil or condensate be present in the blowout flow, liquid hydrocarbons could be an added source of negative impact on the benthos.

Turbid waters allow less light penetrating to depth, which may result in reduced photosynthesis by the symbiotic zooxanthellae that live in hermatypic coral tissue and by calcareous algae (Rogers, 1990). Long-term exposures to turbidity have even resulted in significantly reduced skeletal extension rates in the scleractinian coral *Montastraea annularis* (Torres, 2001; Dodge et al., 1974) and acute decrease in calcification rates of *Madracis mirabilis* and *Agaricia agaricites* (Bak, 1978). The higher the concentration of suspended sediment in the water column and the longer the sediment remains suspended, the greater the impact.

Suspended sediment that is transported by currents in the water column may impact the benthic organisms on live-bottom features. Low-relief features may experience deposition of sediment that settles out of upper layers of the water column. Sediment deposition may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, reducing light intensity, and causing physical abrasion (Wilber et al., 2005). Corals may experience reduced colony coverage, changes in species diversity and dominance patterns, alterations in growth rates and forms, decreased calcification, decreased photosynthesis, increased respiration, increased production in mucus, loss of zooxanthellae, lesions, reduced recruitment, and mortality (Torres et al., 2001; Telesnicki and Goldberg, 1995). Coral larvae settlement may also be inhibited in areas where sediment has covered available substrate (Rogers, 1990; Goh and Lee, 2008). Gorgonian larvae, for example, only settle on substrate that does not have accumulated sediment (Grigg, 1977).

Impacts to corals as a result of sedimentation would vary based on coral species, the height to which the coral grows, degree of sedimentation, length of exposure, and the coral's ability to clear the sediment. Impacts may range from sublethal effects such as reduced growth, alteration in form, reduced recruitment and productivity, and slower growth to death (Rogers, 1990).

Corals have some ability to rid themselves of sediment through mucus production and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995). Scleractinian corals are tolerant of short-term sediment exposure and burial, but longer exposures may result in loss of zooxanthellae, polyp swelling, increased mucus production, reduced coral growth, and reduced reef development (Marszalek, 1981; Rice and Hunter, 1992). Bleached tissue as a result of sediment exposure has been reported to recover in approximately a month (Wesseling et al., 1999).

Solitary octocorals and gorgonians, which are abundant on many hard-bottom features, are more tolerant of sediment deposition than colony-forming scleractinian corals because the solitary species grow erect and are flexible, reducing sediment accumulation and allowing easy removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992a). Many of these organisms have even been observed to grow tall enough to resist burial during periods of sediment encroachment (Lissner et al., 1991). Branching and upright forms of scleractinian corals, such as *Madracis mirabilis* and *Agaricia agaricites*, also tend to be more tolerant of sediment deposition than massive, plating, and encrusting forms, such as *Porites astreoides* (Roy and Smith, 1971; Bak, 1978). Some of the more sediment-tolerant scleractinian species in the Gulf of Mexico include *Montastraea cavernosa*, *Siderastrea siderea*, *Siderastrea radians*, and *Diploria strigosa* (Torres et al., 2001; Acevedo et al., 1989; Loya, 1976b). Due to the influence of the Mississippi River in the CPA, waters are more turbid near the outflow of the River, and more turbidity tolerant species are present on live bottoms in this portion of the Gulf of Mexico. Because many of the species are more tolerant of turbidity and sedimentation, they could better survive exposure to increased sediment input that could result from an accidental event (Gittings et al., 1992a).

Since BOEM policy would preclude bottom-disturbing activity near a low-relief, live-bottom feature and because the blocks that have these features are currently not for lease, most adverse effects on live-bottom features from blowouts would likely be prevented. Petroleum-producing activities would be far enough removed that heavy layers of sediment suspended as a result of a blowout should settle out of the water column before they reach sensitive biological communities. Other particles that travel with currents should become dispersed as they travel, reducing turbidity and depositional impacts.

Response Activity Impacts

Oil-spill-response activity may also impact sessile benthic features. Booms anchored to the seafloor are sometimes used to control the movement of oil at the water surface. Boom anchors can physically impact corals and other sessile benthic organisms, especially when booms are moved around by waves (Tokotch, 2010). Vessel anchorage and decontamination stations set up during response efforts may also break or kill hard-bottom features as a result of setting anchors. Anchor damage may result in the crushing and breaking of hard bottoms and associated communities. It may also result in community alteration through reduced or altered substrate cover, loss of sensitive species, and a reduction in coral cover in heavily damaged areas (Dinsdale and Harriott, 2004). Anchoring often destroys a wide swath of habitat by the anchor being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to corals as a result of anchoring may take 10 or more years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). Nearby species on these hard-bottom habitats that disperse larvae short distances, such as solitary species (cup corals, octocorals, and hydrocorals) may recolonize areas more rapidly than slow-growing colonial forms that disperse larvae great distances (Lissner et al., 1991). Effort should be made to keep vessel anchorage areas away from sensitive benthic features to minimize impact.

Drilling muds comprised primarily of barite may be pumped into a well to stop a blowout. If a “kill” is not successful, the mud may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. The BOEM conducts site-specific reviews to determine if hard bottoms are located near proposed bottom-disturbing activity, and because the areas with live bottoms are not currently offered for a lease sale, a well should be far enough away from live-bottom features to prevent extruded drilling muds from smothering sensitive benthic communities. However, if drilling muds were to travel far enough or high enough in the water column to contact a hard-bottom community, the fluid may smother the existing community. Low-relief communities would be more at risk for burial than the higher features in the GOM. Experiments indicate that corals perish faster when buried beneath drilling mud than when buried beneath carbonate sediments (Thompson, 1979). Turbidity impacts may result in reduced photosynthesis or reduced growth (Rogers, 1990; Torres, 2001). Light layers of deposited sediment would most likely be removed by mucus and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995).

Protection of Live-Bottom (Low-Relief) Communities

Although a Live Bottom (Low Relief) Stipulation would not be applied to a CPA lease sale (because live-bottom [low-relief] blocks are not included in a CPA proposed action), BOEM will still be conducting reviews of proposed OCS activities so that any live bottoms that could be impacted by the proposed activity are protected. A BOEM seafloor review is designed to prevent routine petroleum-producing activities from damaging the low-relief features. Under BOEM's review, plans will be reviewed on a case-by-case basis to determine whether a proposed operation could impact a live bottom. If it is determined from site-specific information derived from BOEM studies, published information from other research programs, geohazards survey information, or another source that the operation would impact a live-bottom area, the operator may be required to relocate the proposed operation or conduct additional mitigation measures.

Although BOEM's case-by-case seafloor review will prevent routine bottom-disturbing activities from impacting live-bottom features, some effects may occur to benthic organisms as a result of an oil spill. Sublethal impacts may include exposure to low levels of oil, dispersed oil, or sedimented oil and turbidity and sedimentation from disturbed sediments. Effects from these exposures may include reduced growth, altered behavior, decreased community diversity, altered community composition, reduction in coral cover, and reduced reproductive success. The severity of these impacts may be dependent on the concentration and duration of exposure. If concentrated oil is carried to live-bottom habitats in a subsea plume, severe lethal effects could result to localized community habitats (Dodge et al., 1984; Wyers et al., 1986). Recovery could take 10 years or more (MRRI, 1984; Fucik et al., 1984; Rogers and Garrison, 2001).

Proposed Action Analysis

Accidental releases of oil could occur as a result of a CPA proposed action. Small spills (0-1.0 bbl) would have the greatest number of occurrences (**Table 3-12**). Estimates of the number of small scale releases as a result of a CPA proposed action range from ~930 to ~1,800 spills. These spills would be small in volume and rapidly diluted by surrounding water. A larger-scale spill, ≥1,000 bbl, is very unlikely, and based on historical spill rates and projected production for a CPA proposed action, up to one spill of this volume may occur as a result of a CPA proposed action. If a large-scale release of oil were to occur, impacts would be more widely spread.

The probability of surface water oiling occurring as a result of a CPA proposed action anywhere between the shoreline and 300-m (984-ft) depth contour, which includes the shoreline to the 100-m (328-ft) depth contour where live-bottom features are located, was estimated by the Bureau of Ocean Energy Management's OSRA model for spills ≥1,000 bbl. For surface waters of Alabama polygon, the OSRA model estimated that probabilities of 2-5 percent and 4-7 percent after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**). For surface waters of the Florida Panhandle polygon, the OSRA model estimated probabilities of 1 percent and 2-4 percent after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**). For all other regions of Florida, including the Florida Bend, Florida Southwest, and Florida Keys polygons, the probability of a spill occurring and contacting these areas was no larger than 1 percent (**Figure 3-24**).

Probabilities of oil contacting the surface water above HAPC's are all very low for regions, including the Florida Middle Grounds, Madison-Swanson Marine Reserve, Tortugas North and South Ecological Reserves, Pulley Ridge, and the Florida Keys National Marine Sanctuary **(Figure 3-25**). The probability of a spill ≥1,000 bbl originating from a CPA proposed action and contacting these areas is at most 1 percent.

The BOEM blocks for which the Live Bottom (Low Relief) Stipulation applies are found in the EPA in water depths of less than 100 m (328 ft) and are located in the northeastern portion of the CPA. Although none of these blocks occur in an area to be offered by a CPA proposed action, a few of the blocks are adjacent to the area to be offered and are protected from impacts by oil gas activity through BOEM policies. Any impacting activity whose impacts could extend beyond the area to be offered by a

CPA proposed action into a live-bottom (low-relief) area would be restricted from contacting those sensitive habitats.

The fact that the live-bottom (low-relief) features do not coincide with the area to be offered by a CPA proposed action and that they are widely dispersed, combined with the probable random nature of any potential oil-spill locations, would serve to limit the extent of damage from any given oil spill to a live-bottom (low-relief) community.

If a surface oil spill is mixed into the water column, the oil is not expected to penetrate below a depth of about 10 m (33 ft). The limited depth of oil penetration into the water column shields the bottom habitats from oil fouling. Also, the low probabilities of oil reaching the surface waters above these features, based on the OSRA model, combined with the limited depth of mixing of surface oil to the crests of these features, function to protect these features. However, the use of dispersants could result in oil mixing into the water column and potentially reaching live-bottom (low-relief) communities.

Blowouts would not occur near live-bottom (low-relief) features since the habitats are not in the CPA sale area. Furthermore, blowouts in blocks adjacent to live-bottom (low-relief) features are unlikely to impact the biota because oil would rapidly float to the surface. Oil that is ejected under pressure may produce tiny droplets that become entrained in the water column and that could possibly affect the live-bottom (low-relief) communities. Sedimented oil would only reach a live-bottom (low-relief) community if both the spill and the community are near the border of a CPA proposed action.

Potential impacts to the live-bottom (low-relief) communities adjacent to the CPA from oil spills and blowouts are unlikely and are not expected to be significant. Chemical spills are also infrequent, of small quantity, and usually occur in surface waters. The BOEM policies for live-bottom (low-relief) areas would assist in preventing most of the potential impacts from oil and gas operations, including accidental oil spills, blowouts, and chemical spills. No significant impacts to the live-bottom (low-relief) area adjacent to a CPA proposed action are expected.

Summary and Conclusion

Live-bottom (low-relief) features represent a small fraction of the continental shelf area in the CPA. The fact that the live-bottom features are widely dispersed, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to the live-bottom features.

The BOEM's case-by-case review of the seafloor in areas where bottom-disturbing activities are planned would prevent most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of live-bottom features by increasing the distance of such events from the features. Also, note that none of the blocks with live bottoms are included in the area to be offered in a CPA proposed action. However, operations that occur in blocks adjacent to live-bottom habitat may affect live-bottom features. It would be expected though that the majority of oil would rise to the surface and that the most heavily oiled sediments would likely be deposited before reaching the live-bottom features.

The limited relief of many live-bottom features helps to protect them from surface oil spills. Because the concentration of oil becomes diluted as it physically mixes with the surrounding water and as it moves into the water column, any oil that might be driven to 10 m (33 ft) or deeper would probably be at concentrations low enough to reduce impact to these features. Any features in water shallower than 10 m (33 ft) would be located far from the source of activities in a CPA proposed action.

A subsurface spill or plume may impact sessile biota of live-bottom features. Oil or dispersed oil may cause sublethal impacts to benthic organisms if a plume reaches these features. Impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. The distance of proposed activities from low-relief live bottoms provides considerable protection for the habitats. The BOEM's site-specific review of seafloor habitats during the review of project plans would limit the potential impact of any activities that may approach low-relief habitats (such as pipeline right-of-ways) because BOEM policy keeps the sources of such adverse events geographically removed from the sensitive biological resources of live-bottom features. The distance would serve to reduce turbidity and sedimentation, and any sedimented oil should be well dispersed, resulting in a light layer of deposition that would have low toxicity and be easily removed by the organism. Many of these organisms are located within the influence of the Mississippi River plume and are more tolerant of turbidity and sedimentation, allowing them to withstand a degree of these impacts.

The BOEM's site review would assist in preventing most of the potential impacts on live-bottom communities from blowouts, surface, and subsurface oil spills and the associated effects because BOEM policy requires that bottom-disturbing activity be distanced from live-bottom features. In addition, because no live-bottom (low-relief) blocks are included in a CPA proposed action, the live-bottom features are distanced from oil-producing activity. Any contact with spilled oil would likely cause sublethal effects to benthic organisms because the distance of activity would prevent contact with concentrated oil. In the unlikely event that oil from a subsurface spill would reach the biota of a live-bottom feature, the effects would be primarily sublethal and impacts would be at the community level. Any turbidity, sedimentation, and sedimented oil would also be at low concentrations by the time the live-bottom features were reached, resulting in sublethal impacts.

4.2.1.6.2.4. Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a CPA proposed action plus those related to prior and future OCS lease sales, and to tanker and other shipping operations that may occur and adversely affect live bottoms of low-relief, hard-bottom areas. A description of live-bottom (low-relief) areas is given in **Chapter 4.2.1.6.2.1**. Specific OCS-related, impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, blowouts, and operational discharges. Non-OCS-related impacts, including commercial fisheries, natural disturbances, anchoring by recreational boats, and other non-OCS commercial vessels, as well as spillage from import tankering, all have the potential to alter live bottoms, and they are discussed here as well.

Oil and gas activities from this action do not coincide with the live-bottom (low-relief) habitats that are in the EPA and the northeast corner of the CPA; those blocks are excluded from a CPA proposed action. Some of the areas leased as a result of a CPA proposed action could be adjacent to the sensitive habitats at the extreme western edge of the habitat range. The BOEM conducts seafloor reviews of proposed OCS activities prior to granting permits for seafloor-disturbing activity. The permit granted following the site-specific review requires that the bottom-disturbing activity be distanced from the live-bottom habitat to protect the organisms. However, BOEM's seafloor reviews, stipulations, and mitigations do not protect the resources from activities outside of BOEM's jurisdiction (i.e., commercial fishing, tanker and shipping operations, or recreational activities).

OCS Leasing-Related Impacts

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels that disturb areas of the seafloor are considered the greatest oil and gas OCS-related threat to low-relief, hard-bottom areas. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current (Lissner et al., 1991). Anchor damage could include crushing and breaking of live bottoms and associated communities. It may also result in community alteration through reduced or altered substrate cover, loss of sensitive species, and a reduction in coral cover in heavily damaged areas (Dinsdale and Harriott, 2004). Anchoring often destroys a wide swath of habitat by the anchor being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to corals as a result of anchoring may take 10 or more years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). Nearby species on these hard-bottom habitats that disperse larvae short distances, such as solitary species (cup corals, octocorals, and hydrocorals), may recolonize areas more rapidly than slow-growing colonial forms that disperse larvae great distances (Lissner et al., 1991). Such anchoring damage, however, should be minimized on live-bottom habitats since BOEM reviews OCS activity on a case-by-case basis and does not allow bottom-disturbing activities to impact hard-bottom areas. Also, the blocks that house the live-bottom (low-relief) habitat are not currently being offered in a CPA proposed action.

Both explosive and nonexplosive structure-removal operations disturb the seafloor; however, they are not expected to affect live-bottom (low-relief) communities because such communities are not in the area to be offered in a CPA proposed action and because many sessile benthic organisms are known to resist the concussive force of structure-removal-type blasts (O'Keeffe and Young, 1984). Also, BSEE regulations require charges to be detonated 5 m (15 ft) below the mudline and 0.9 seconds apart, which would attenuate shock waves in the seafloor (Baxter et al., 1982).

Routine discharges of drilling muds and cuttings by oil and gas operations could affect biological communities and organisms through a variety of mechanisms, including the smothering of organisms through deposition or less obvious sublethal effects (impacts to growth and reproduction). The live-bottom (low-relief) areas, however, are not in the area to be offered in a CPA proposed action and any areas that may experience seafloor disturbance as part of OCS-related production will be reviewed by BOEM for the presence of hard-bottom communities. Even though the additive effects of drilling several wells adds more discharges to the environment, a CPA proposed action would be separated from the live-bottom (low-relief) communities by distance.

Drilling muds quickly disperse upon release and most of the material is rapidly deposited on the seafloor (Neff, 2005; Shinn et al., 1980; Hudson et al., 1982). The drilling fluid plume in the water column has been measured to be only a few milligrams per liter above background sediment concentrations 100 m (328 ft) from the discharge point, concentrations often less than those produced during storms or from boat wakes (Shinn et al., 1980). Deposition of drilling muds and cuttings in low-relief areas are not expected to greatly impact the biota of the surrounding habitat for four reasons. First, the biota near a CPA proposed action that live on the low-relief, hard-bottom communities are adapted to turbid conditions and storm impacts (Chiappone and Sullivan, 1994; Gittings et al., 1992a), reducing their vulnerability to sedimentation. Second, BOEM policy does not allow the disturbance of low-relief, hard-bottom communities and often requires bottom shunting of drilling material away from the sensitive habitat or requires that it be transported to approved disposal sites. Third, USEPA discharge regulations and permits would further reduce discharge-related impacts. Fourth, the blocks containing low-relief habitats are not currently being offered for lease. Any exposure that may occur from muds and cuttings discharged as a result of the cumulative scenario would be temporary, primarily sublethal in nature, and the effects would be limited to small areas.

Produced waters from petroleum operations are not likely to have a great impact on live bottoms. Produced waters are rapidly diluted, acute impacts are generally only observed within proximity of the discharge point, and acute toxicity that may result from produced waters occurs "within the immediate mixing zone around a production platform" (Gittings et al., 1992b; Holdway, 2002). Also, USEPA's general NPDES permit restrictions on the discharge of produced water, which require the effluent concentration 100 m (328 ft) from the outfall to be less than the 7-day "no observable effect concentration" based on laboratory exposures (Smith et al., 1994).

Since the low-relief live bottoms are not included in the area to be offered in a CPA proposed action and because of BOEM's site-specific seafloor review and possible site-specific mitigations, operators are not expected to place pipelines directly upon live-bottom communities. The effect of pipeline-laying activities on the biota of these communities would be restricted to the resuspension of sediments, possibly causing obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Impacts may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003).

Because the low-relief live bottoms are not included in the area to be offered in a CPA proposed action and because of the other BOEM protection policies, hard-bottom communities would be protected from experiencing direct oiling as a result of a blowout as bottom-disturbing activities are not permitted to impact these communities. However, surface oil spills and dispersed oil may impact hard-bottom communities. Disturbance of the sea surface by storms can mix surface oil 10-20 m (33-66 ft) into the water column (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). This may result in direct oil contact for shallow, nearshore live-bottom communities. Direct oiling may result in lethal impacts to organisms or sublethal responses such as reduced feeding (Lewis, 1971; Cohen et al., 1977; Reimer, 1975), tissue damage (Peters et al., 1981; Reimer, 1975), decreased reproductive ability (Loya and Rinkevich, 1979; Rinkevich and Loya, 1977; Cohen et al., 1977; Guzmán and Holst, 1993), reduced photosynthesis (Cook and Knap, 1983; Rinkevich and Loya, 1983; Loya and Rinkevich, 1979; Peters et al., 1981), incorporation of petroleum hydrocarbons into their tissue (Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992; Cohen et al., 1977), and reduced community resilience (Jackson et al., 1989; Loya, 1976a).

Live-bottom (low-relief) communities farther offshore (out to 100 m [328 ft]), would be protected from direct physical oil contact by depth below the sea surface due to their depth below the water's surface and oil's limited depth of mixing. Any dispersed surface oil from a tanker or rig spill that may reach the benthic communities of low-relief features in the Gulf of Mexico at a depth greater than 10 m (33 ft) would be expected to be at very low concentrations (less than 1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations would not be life threatening to larval or adult stages, based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed or physically mixed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Potential blowouts are unlikely to impact the biota of the live-bottom (low-relief) features because they are not in the area to be offered in a CPA proposed action and because of BOEM policy that does not allow drilling in areas of low-relief, hard-bottom communities. Therefore, these sensitive habitats are distanced from the potential lethal impacts of a blowout. If any blowouts from wells did occur, the suspended sediments should settle out of the water column before a majority of the material reached low-relief habitats. Any oil that becomes entrained in a subsurface plume will be dispersed as it travels in the water column (Vandermuelen, 1982; Tkalich and Chan, 2002). If oil were to contact the live-bottom features, concentrations should be sublethal, and the impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. In the highly unlikely event that oil from a subsurface spill could reach a coral-covered area in lethal concentrations, the recovery of this area could take in excess of 10 years (Fucik et al., 1984).

The greatest impact from an oil spill could result from dispersed oil trapped in stratified layers of water, such as that which occurred during the DWH event. A recent report documents damage to a deepwater coral community 11 km (7 mi) southwest of the DWH event (USDOI, BOEMRE, 2010j) at a depth where a dispersed plume of oil was trapped in a stratified water layer (OSAT, 2010). A probable explanation for the detrimental impacts to corals is that the coral community forms structures that protrude up into the water column that would be affected by a passing oil plume. The DWH event was the first usage of subsea dispersants, but if subsea dispersants are ever applied on the continental shelf, a similar occurrence may happen. A stratified nepheloid (turbid) layer exists near the seafloor and rises to 20 m (66 ft) from the seafloor, and if a dispersant is used in that layer near a live bottom, dispersed oil could affect the sensitive communities. But as stated above, the use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis. Also, NOAA's policy requests that dispersants be applied as far as possible from the Flower Gardens National Marine Sanctuary, and although there is no policy to protect the live bottoms from dispersant usage, similar requests may be made. The BOEM considers it unlikely that concentrated dispersants would be applied near live-bottom (low-relief) features, but the decision on how and where to use dispersants is outside of BOEM's control.

As noted in the description of the affected environment above, limited data are currently available on potential impacts of the DWH event on live-bottom (low-relief) features in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to live-bottom (low-relief) features. The BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives. Relevant data on the status of live-bottom (low-relief) features after the DWH event, however, may take years to acquire and analyze. Much of this data is being developed through the NRDA process, which is expected to take years to complete. Little data from the NRDA process have been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In the place of this incomplete or unavailable information, as noted above, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

The cumulative impact of possible oil spills, along with the DWH event, is not anticipated to affect the overall live-bottom (low-relief) habitat. The BOEM policy would not allow wells to be drilled in the habitats and currently the locations of these habitats are not being offered for lease. These two factors separate the habitat from the worst of the sediment deposition of a blowout and allow most of the oil to rise to the sea surface without contacting live-bottom features. If oil is released near a live-bottom feature and concentrated or dispersed oil is entrained in the water column, it could contact nearby low-relief habitats with serious detrimental effects. Habitats receiving high concentrations of oil could take 10 or more years to recover (Fucik et al., 1984). However, since subsea plumes travel directionally with water currents, only low-relief habitats directly in the path of the plume would be affected. Therefore, the acute impacts of any large-scale blowout would likely be limited in scale, and any additive impacts of several blowouts should only impact small areas on an acute level, with possible sublethal impacts occurring over a larger area.

Non-OCS Leasing Impacts

Although BOEM policy prohibits bottom-disturbing activities for OCS-related construction, these regulations do not apply to non-OCS-related activity. Severe and permanent physical damage may occur to low-relief features and the associated live bottoms as a result of non-OCS activities. It is assumed those biota associated with live bottoms of the CPA are well adapted to natural disturbances such as turbidity and storms; however, human disturbance could cause severe damage to live-bottom biota, possibly leading to changes of physical integrity, species diversity, or biological productivity. If such events were to occur, recovery to pre-impact conditions could take as much as 10 years (Fucik et al., 1984).

Non-OCS activities have a greater potential to affect the hard-bottom communities of the region than BOEM-regulated activities. Natural events such as storms, extreme weather, and fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms) may impact live-bottom communities. Live-bottom (low-relief) communities occur from the shoreline to 100 m (328 ft) of water and, because many of these features are located in shallow water, storm events may damage these environments. Currents are created by wave action that can resuspend sediments to produce added turbidity and sedimentation (Brooks, 1991; CSA, 1992b). Storms can physically affect shallow-bottom environments, causing an increase in sedimentation, burial of organisms by sediment, a rapid change in salinity or dissolved oxygen levels, storm surge scouring, remobilization of contaminants in the sediment, and abrasion and clogging of gills as a result of turbidity (Engle et al., 2008). Storms have also been shown to uproot benthic organisms from the sediment (Dobbs and Vozarik, 1983) and breakage or detachment may occur as a result of storm activity (Yoshioka and Yoshioka, 1987). Such impacts may be devastating to a benthic community.

Hypoxic conditions of inconsistent intensities and ranges also occur annually in a band that stretches along the Louisiana-Texas shelf each summer (Rabalais et al., 2002a). The dissolved oxygen levels of bottom waters in the Gulf of Mexico hypoxic zone are less than 2 ppm during part of the summer season. Such low concentrations are lethal to many benthic organisms and may result in the loss of some benthic populations. Although this is mainly a character of the Louisiana-Texas shelf, its effect could reach some live-bottom (low-relief) communities in the northeast portion of the CPA.

Recreational boating, fishing, and import tankering may severely impact local areas of live-bottom communities. Ships anchoring near major shipping fairways of the CPA or EPA may occasionally impact sensitive areas located near these fairways. Recreational and commercial fishermen also take advantage of the relatively shallow and easily accessible resources of the region and anchor at hard-bottom locations to fish. Much of the fishing on these habitats uses bottom fishing gear that may damage benthic organisms or may snag on the reefs and be lost. Such gear, particularly lines of varying thickness, can cut into the tissues of many benthic organisms during storm movement of bottom waters.

Damage resulting from commercial fishing, especially bottom trawling, may have a severe impact on hard-bottom benthic communities. Bottom trawling in the Gulf of Mexico primarily targets shrimp from nearshore waters to depths of approximately 90 m (300 ft) (NRC, 2002). Although trawlers would not select areas with sharp relief as fishing ground, since rocky areas may entangle gear, many live-bottom areas have little or no relief and may be targeted by trawlers. Reports indicate that bottom trawling activity on hard-bottom substrates can overturn boulders and destroy epifaunal organisms (Freese et al., 1999). Large emergent sponges and anthozoans may be particularly vulnerable to trawling activity, as these organisms grow above the substrate and can be caught and removed by trawling activity (Freese et al., 1999). Recovery rates of corals and coralline algae may take decades and depend on the extent of the impact, frequency of disturbance, other natural changes that occur to the habitat, and the organism's life history (NRC, 2002).

Summary and Conclusion

Non-OCS activities that may occur in the vicinity of the low-relief, hard-bottom communities include boating and fishing, import tankering, fishing and trawling, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions. These activities could cause damage to the low-relief, hard-bottom communities. Occasionally, ships using fairways in the vicinity of communities anchor in the general area of live bottoms and commercial and recreational fishermen take advantage of the relatively shallow and easily accessible resources of regional hard bottoms. These activities could lead to instances of severe and permanent physical damage. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments, which could cause severe mechanical damage to organisms, including abrasion from suspended sand, bruising and crushing from tumbling rocks, and complete removal of organisms (Brooks, 1991; CSA, 1992b). Yearly hypoxic events may affect portions of live-bottom benthic populations in the northeast part of the CPA (Rabalais et al., 2002a).

Possible impacts from routine activities of OCS oil and gas operations include anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, and discharges of produced waters. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to low-relief, hard-bottom communities. Impacts from these factors should be minimized based on BOEM's policy and case-by-case review of proposed OCS activity and the fact that live-bottom (low-relief) blocks are not currently offered for lease. The physical distance between any routine OCS activity and accidental spill would minimize any possible impacts from the activity. The impact to the live-bottom resource as a whole is expected to be minimal because of the distance of any OCS-related activity from these habitats.

The incremental contribution of a CPA proposed action to the cumulative impact is expected to be minimal, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts should be restricted by site-specific BOEM seafloor review, the fact BOEM is not currently offering the low-relief habitats for lease, and the distance of live-bottom habitats from the source of most OCS-related impacts.

4.2.1.7. Topographic Features

The BOEM has protected topographic features that support sensitive benthic communities since the early 1970's. The Gulf of Mexico seafloor in the CPA is mostly mud bottoms with varying mixtures of sand in some areas. Due to periods of lower sea level in geologic history, a thick layer of salt is present in a stratum deep beneath the seafloor. This salt becomes liquid under high pressure and pushes its way up through faults in the seafloor. In doing so, it sometimes forces up rock strata to form a "salt diapir" protruding up above the surrounding soft-bottom seafloor. Wherever these upthrusts of rock protrude into the water column, they form a rock reef that may support reef organisms that are different from those on typical soft bottoms. These reefs are relatively rare on the seafloor compared with the ubiquitous soft bottoms (Parker et al., 1983). These topographic highs, or subsea banks, provide an island of hard substrate in a virtual ocean of soft bottoms. As a result, reef communities develop and include many of the more sensitive species associated with Caribbean waters.

"Topographic features" is a term that specifically refers to 37 subsea banks in the GOM that are protected from potential impacts by oil and gas activities. They are defined in this Agency's NTL 2009-G39, "Biologically-Sensitive Underwater Features and Areas," as "isolated areas of moderate to high relief that provide habitat for hard-bottom communities of high biomass and diversity and large numbers of plant and animal species, and support, either as shelter or food, large numbers of commercially and recreationally important fishes."

Over time, knowledge of these communities has increased and protective measures have evolved. This Agency has conducted environmental studies in the GOM for the past 35 years. Protective measures were instituted based on the nature and sensitivity of bank habitats and their associated communities. These protections have developed into stipulations applied to OCS leases. The lease stipulations establish five categories of protection zones: No Activity Zone; 1,000-Meter Zone; 1-Mile Zone; 3-Mile Zone; and the 4-Mile Zone. The No Activity Zone surrounds the core of the bank and prohibits any contact with the seafloor. The other zones are buffers with restrictions on the discharge of drill cuttings. All 37 banks have the No Activity Zone and may have up to two of the other zones. Details of the restrictions are described in this Agency's NTL 2009-G39. The Biological Stipulation Map Package (http://boem.gov/Regulations/Notices-To-Lessees/Notices-to-Lessees-and-Operators.aspx) includes drawings of each bank with associated protection zones.

The BOEM has examined the topographic features based on the information presented below. Results of searches that were conducted for available data indicating the impacts to topographic features as a result of the DWH event have also been included in this assessment. Full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a CPA proposed action are presented in this EIS.

4.2.1.7.1. Description of the Affected Environment

Topographic features are hard-bottom habitats and are rare compared with the ubiquitous soft bottoms in the GOM (Parker et al., 1983). They are typically upthrusts of rock due to uplift (salt diapirs) by underlying layers of salt deep under the seafloor. These topographic highs, or subsea banks, provide an island of hard substrate in a virtual ocean of soft bottoms.

Wherever rock protrudes up into the water column, reef organisms may thrive. The type of organisms inhabiting a reef is determined by environmental conditions. Major factors are the amount of light and sedimentation and the temperature. If conditions are very good, a coral reef is established; this is found in the WPA only at the Flower Garden Banks. Other reefs (rocky upthrusts) are too deep in the water (causing too dark of an environment) or have too much sedimentation for hermatypic (reef-building) corals to thrive in numbers adequate to build a coral reef. However, these deeper reefs have thriving communities that include some stony corals as well as gorgonians, black corals, soft corals, sponges, urchins, crabs, many other invertebrates, macroalgae, calcareous algae, and a healthy fish community. The characteristics of protected topographic features in the GOM are described in more detail below.

The habitat created by the topographic features and the organisms found upon them is important for the following reasons:

- they support hard-bottom communities of high biomass, high diversity, and high numbers of plant and animal species;
- they provide shelter, food, and nursery grounds that support large numbers of commercially and recreationally important fishes;
- they are a unique and valuable component of the much larger ecosystem, providing essential functions not available elsewhere;
- they provide a relatively pristine area suitable for scientific research (especially the East and West Flower Garden Banks); and
- they have an aesthetically intrinsic value.

Figure 4-5 depicts the location of 37 protected topographic features in the GOM; 21 in the WPA and 16 in the CPA. In 1998, USGS, in cooperation with BOEM and the Flower Garden Banks National Marine Sanctuary, surveyed the East and West Flower Garden Banks using high-resolution, multibeam mapping techniques (Gardner et al., 1998). In 2002, the same consortium mapped 12 more topographic features, including Rankin (1 and 2) and MacNeil Banks in the WPA; and Alderdice, Sonnier, Geyer, Bright, Jakkula, Bouma, McGrail, Rezak, and Sidner Banks in the CPA (Gardner et al., 2002).

A total of 16 topographic features are protected in the CPA. This Agency has created No Activity Zones around major topographic features in order to protect these habitats from disruption due to oil and gas activities. A No Activity Zone is a protective perimeter associated with a specific depth contour that is drawn around each feature; no contact with the seafloor is allowed including the placement of structures, drilling rigs, pipelines, anchoring and cables. These No Activity Zones are areas protected by BOEM policy. In addition, based on EFH programmatic consultation with NMFS, NTL 2009-G39 also recommends that drilling would not occur within 152 m (500 ft) of a No Activity Zone of a topographic feature. Any construction within the buffer would require project-specific EFH consultation with NMFS, which could extend the time necessary to complete BOEM's review of the project application.

The surveys conducted by Gardner et al. (1998 and 2002) revealed complex bathymetry in some areas surrounding the banks outside the No Activity Zones. Small seafloor features of moderate to high relief (8 ft [2.4 m] or higher) outside of the No Activity Zones of the larger banks are called "potentially sensitive biological features" and are considered important fish habitat. The potentially sensitive biological features provide surface area for the growth of sessile invertebrates and attract large numbers of fish. They are protected by BOEM from impacts of oil and gas activities as described by NTL 2009-G39 in that no bottom-disturbing activities may cause impacts to potentially sensitive biological features.

Benthic organisms on these topographic features are mainly limited by temperature, sedimentation, and light. Extreme water temperature and light intensity are known to stress corals. Temperatures lower than 16 ^{o}C (60.8 ^{o}F) reduce coral growth, while temperatures in excess of 34.4 ^{o}C (93.2 ^{o}F) impede coral growth and induce coral bleaching (loss of symbiotic zooxanthellae) (Kleypas et al., 1999a). While intertidal corals are adapted to high light intensity, most corals become stressed when exposed to unusually high light levels. Furthermore, although corals will grow or survive under low light level conditions, they do best submerged in clear, nutrient-poor waters (Kleypas et al., 1999a).

Light penetration in the Gulf is limited by several factors including depth and events of prolonged turbidity. Hard substrates favorable to colonization by hermatypic coral communities in the northern Gulf are found on outer shelf, high-relief features. These substrates protrude above the nepheloid layer (layer of high turbidity) that lies above the muddy seafloor and are bathed most of the year in nutrient-poor waters (Rezak et al., 1990). The depth of these banks (18 m [59 ft] or more below the sea surface) reduces the effects of storms on the habitats. Whereas typical Caribbean shore reefs can suffer extensive damage from tropical storms, only the strongest storms reach down to reefs in the GOM. The most common influence of strong storms on these banks is an increase in turbidity, generally at the lower levels of the banks (Rezak et al., 1990). Turbidity and sedimentation are normal in these lower levels because of the nepheloid layer and normal resuspension of soft bottom sediments.

Gulf of Mexico reefs span a range of environments, resulting in a range of community types. Habitats that can be classified as true coral reefs are few in the northern GOM: limited to the East and West Flower Garden Banks, a small area of McGrail Bank, and part of Pulley Ridge (in the eastern GOM). Other banks support reef communities with varying degrees of diversity, depending on environmental conditions. Many of these harbor a variety of corals, including some hermatypic corals, but not in densities that build a thriving, accreting coral reef. The banks of the GOM have been identified and classified into seven distinct biotic zones (**Table 4-4**) (modified/from Rezak and Bright, 1981; Rezak et al., 1983); however, none of the banks contain all seven zones. The zones are divided into the following four categories depending upon the degree of reef-building activity in each zone.

Zones of Major Reef Building and Primary Production

Diploria-Montastraea-Porites Zone

This zone is characterized by 18-20 hermatypic coral species and is only found at the East and West Flower Garden Banks in the WPA in water depths less than 36 m (118 ft) (Rezak et al., 1990). The most abundant species of the zone in order of dominance are the *Montastraea annularis complex* (this group includes *M. franksi*, *M. faveolata,* and *M. annularis*), *Diploria strigosa*, *Porites astreoides,* and *Montastraea cavernosa* (Precht et al., 2008; Robbart et al., 2009). Coralline algae are abundant in areas, which adds substantial amounts of calcium carbonate to the substrate and serves to cement the reef together. In addition to the coralline algae, there is a considerable amount of bare reef rock, which fluctuates in percent cover with the appearance of a red-turf like algae.

Typical sport and commercial fish and invertebrates observed in this zone include various grouper species; amberjack; barracuda; red, gray, and vermilion snapper; cottonwick; porgy; spiny lobsters; and shovel-nosed lobster (Rezak et al., 1983). There is also a diverse group of tropical reef fish species found on these banks, including creole fish; queen, stoplight, red band, and princess parrot fish; rock beauty; blue tang, and the whitespotted filefish, just to name a few. There are over 175 tropical reef species that reside within the high-diversity zone at the Flower Garden Banks (Dennis and Bright, 1988; Pattengill, 1998).

Madracis and Fleshy Algal Zone

The *Madracis* Zone is dominated by the small branching coral *Madracis mirabilis,* which produces large amounts of carbonate sediment (Rezak et al., 1990). In places, large (possibly ephemeral) populations of turf-like algae dominate the *Madracis* gravel substratum (Algal Zone). The *Madracis* Zone appears to have a successional relationship with the *Diploria-Montastraea-Porites* Zone. *Madracis* colony rubble builds up the substrate and allows the successional species to grow (Rezak et al., 1983). The zone occurs at the East and West Flower Garden Banks on peripheral components of the main reef structure between 28 and 46 m (92 and 151 ft) (Rezak et al., 1990).

Stephanocoenia-Millepora Zone

The *Stephanocoenia-Millepora* Zone is inhabited by a low-diversity coral assemblage of 12 hermatypic corals and can be found at McGrail, and Bright Banks in the CPA. The eight most conspicuous corals in order of dominance are *Stephanocoenia michelini, Millepora alcicornis, Montastraea cavernosa, Colpophyllia natans, Diploria strigosa, Agaricia agaricites, Mussa angulosa*, and *Scolymia cubensis* (Rezak et al., 1983). The assemblages associated with this zone are not well known; coralline algae is the dominant organism in the zone. The American thorny oyster (*Spondylus americanus*) is common in this zone along with populations of some reef fish (Rezak et al., 1983). The depth range of this zone is between 36 and 52 m (118 and 171 ft) (Rezak et al., 1990).

Algal-Sponge Zone

The Algal-Sponge Zone covers the largest area among the reef-building zones. Sonnier, McGrail, Geyer, and Bright banks all exhibit this community. The dominant organisms of the zone are the coralline algae, which are the most important carbonate producers. The algae produce nodules called "rhodoliths," which are composed of over 50 percent coralline algae, and form large beds on the seafloor. The rhodoliths range from 1 to 10 cm (0.4 to 4 in) in size, cover 50-80 percent of the bottom, and generally occur in water depths between 55 and 85 m (180 and 280 ft) (Rezak et al., 1983). The habitat created by the alga nodules supports communities that are probably as diverse as the coral-reef communities. Most of the leafy algae found on the banks occur in this zone and contribute large amounts of food to the surrounding communities. Calcareous green algae (*Halimeda* and *Udotea)* and several species of hermatypic corals are major contributors to the substrate (Rezak et al., 1983). Deepwater alcyonarians are abundant in the lower Algal-Sponge Zone. Sponges, especially *Neofibularia nolitangere,* are conspicuous. Echinoderms are abundant and also add to the carbonate substrate. Small gastropods and pelecypods are abundant (Rezak et al., 1983). Gastropod shells are known to form the center of some of the algal nodules. Characteristic fish of the zone are yellowtail reef fish, sand tilefish, cherubfish, and orangeback bass (Rezak et al., 1983).

Partly drowned reefs are a major substrate of the Algal-Sponge Zone. They are shallow carbonate reefs that are outpaced by sea-level rise and subsidence (Schlager, 1981). Their accumulation of carbonate is slower than relative sea-level rise so that, over time, they are found deeper and deeper in the water until they are no longer an accreting coral reef. In addition to the organisms typical to the rest of the Algal-Sponge Zone, the partly drowned reefs are also inhabited by large anemones, large comatulid crinoids, basket stars, limited crusts of *Millepora*, and infrequent small colonies of other hermatypic species (Rezak et al., 1983). The relief and habitat provided by the carbonate structures also attract a variety of fish species, especially yellowtail reef fish, reef butterfly fish, spotfin hogfish, orangeback bass, cherubfish, wrasse bass, longjaw squirrelfish, and several grouper species (Dennis and Bright, 1988).

Zone of Minor Reef Building

Millepora-Sponge Zone

The *Millepora*-Sponge Zone occupies depths comparable to the *Diploria-Montastraea-Porites* Zone on the claystone-siltstone substrate of the Texas-Louisiana midshelf banks. Sonnier Bank exhibits this community between 18 and 52 m (Robbart et al., 2009). One shelf-edge carbonate bank, Geyer Bank, also exhibits the zone but only on a bedrock prominence. Crusts of the hydrozoan coral, *Millepora alcicornis*, sponges, and other epifauna occupy the tops of siltstone, claystone, or sandstone outcrops in this zone. Scleractinian corals and coralline algae are rarely observed, largely due to seasonal temperatures that drop below the 18 ^{o}C (64 ^{o}F) minimum requirement for vigorous coral reef growth (Rezak et al., 1990).

Transitional Zone of Minor to Negligible Reef Building

Antipatharian Zone

This transitional zone is not distinct but blends in with the lower Algal-Sponge Zone. It is characterized by an abundance of antipatharian whips growing with the algal-sponge assemblage (Rezak et al., 1983). With increased water depth, the assemblages of the zone become less diverse, characterized by antipatharians, comatulid crinoids, few leafy or coralline algae, and limited fish (yellowtail redfish, queen angelfish, blue angelfish, and spotfin hogfish). Again, the depth of this zone differs at the various banks but generally extends to 90-100 m (295-328 ft) (Rezak et al., 1990).

Zone of No Reef Building

Nepheloid Zone

High turbidity, sedimentation, and resuspension occur in this zone. Rocks or drowned reefs are covered with a thin veneer of sediment and epifauna are scarce. The most noticeable are comatulid crinoids, octocoral whips and fans, antipatharians, encrusting sponges, and solitary ahermatypic corals (Rezak et al., 1990). The fish fauna is different and less diverse than those of the coral reefs or partly drowned reefs. These fish species include red snapper, Spanish flag, snowy grouper, bank butterflyfish, scorpionfishes, and roughtongue bass (Rezak et al., 1983). This zone occurs on all banks, but its depth differs at each bank. Generally, the Nepheloid Zone begins at the limit of the Antipatharian Zone and extends to the surrounding soft bottom (Rezak et al., 1990).

Banks of the Central Planning Area

Shelf-Edge Banks	Midshelf Banks	South Texas Banks
Alderdice Bank	Fishnet Bank	WPA Only
Bouma Bank	Sackett Bank	
Bright Bank	Sonnier Bank	
Diaphus Bank		
Elvers Bank		
Ewing Bank		
Geyer Bank		
Jakkula Bank		
McGrail Bank		
Parker Bank		
Rezak Bank		
Sidner Bank		
Sweet Bank		

Shelf-Edge Banks

The shelf-edge banks of the Central Gulf (Geyer, Sackett, Diaphus, Alderice, McGrail, and Bright) (**Figure 4-5**) generally exhibit the *Algal-Sponge* zonation (where present) that transitions into the deep, turbid Nepheloid Zone that is exhibited at these Banks (Rezak et al., 1983). However, Geyer Bank (37 m [121 ft] crest), which is within the depth of the high-diversity, coral-reef zone, does not exhibit the high-diversity characteristics. Instead, Geyer Bank has a well-developed *Millepora*-Sponge Zone, which is typically the defining characteristic of midshelf banks found elsewhere in the GOM (Rezak et al., 1983).

The hydrocoral Millepora and various sponges have dominated the reef crests in the past. A surprising quantity of a benthic *Sargassum* macroalgae was documented by Robbart et al. (2009) in a recent study. The algae grows up to about a 0.5 m (1.5 ft) tall, providing considerable upright structure and cover for invertebrates and fish over a large portion of the reef cap. Upper portions of the bank house small branching corals (*Madracis*), leafy calcareous algae (*Peyssonnelia*), calcareous green algae (*Halimeda*), small agariciid coral colonies, ellisellid sea whips, Cirrhipathes, gastropods, sponges (*Chelotropella*), and crinoids (Rezak et al., 1983). Deeper portions of the Bank provide habitat for small sponges, solitary corals (*Oxysmilia*), branching corals (*Oculina*), octocorals (*Nidalia*), and octocoral fans (Rezak et al., 1983). A coherent mud is present at the bottom of the bank and small ophiuroids, hermit crabs, galatheid crustaceans, swimming scallops, urchins, and flatfishes were observed occupying the sediment (Rezak et al., 1983).

Sackett and Diaphus Banks (**Figure 4-5)** are closest to the Mississippi River and have less diverse communities than other banks as a result of the turbid waters (Rezak et al., 1983). A thin veneer of sediment covers much of Sackett Bank and species present include: comatulid crinoids, encrusting sponges, urchins, black corals, Atlantic thorny oyster, saucer-shaped agariciids, and coralline algae (Rezak et al., 1983). Turbidity tolerant species were present in the Nepheloid Layer including: comatulid crinoids, sponges (*Neofibularia*), white fire worms (*Hermodice*), asteroid star fish (*Narcissia trigonaria*), black corals (*Cirrhipathes*), white sponge (*Geodea*), branching antipatharians (*Antipathes*), club-shaped octocorals (*Nidalia occidentalis*), sea fans, stony corals (*Oxysmilia*), paramuriceids (*Nidalia*), and large solitary corals (Rezak et al., 1983). Diaphus Bank has many drowned reef patches and very little live cover or active growth due to the turbid waters and sediment veneer (Rezak at al., 1983).

Alderice Bank (**Figure 4-5**) is also influenced by the turbidity of the surrounding water. Black corals, sponges, and bryozoans are present at the crest. Below the crest drowned reef structures appear sediment covered mats of low epifaunal growth (Rezak et al., 1983). The deeper muddy bottom houses mobile benthic invertebrates such as the sand dollar (*Clypeaster ravenelli*) and starfish (*Narcissia trigonaria*). Two basalt spires protrude from this bank and attract schools of roughtongue bass, yellowtail reeffish, creole fish, vermillion snapper, grouper, and jacks (Schmahl et al., 2003; Weaver et al., 2006). The community is heavily dominated by roughtongue bass (Weaver et al., 2006).

The crest of McGrail Bank (45 m, 148 ft) (**Figure 4-5**) is dominated by macroalgae communities having about 38 percent cover. Hermatypic corals are common on the crest with a limited area of up to 32 percent coral cover. It is one of the few banks in the northwestern Gulf of Mexico that has reef-building corals other than the East and West Flower Garden Banks (Schmahl et al., 2003). The bank exhibits a *Stephanocoenia-Millepora* Zone and some relatively high coral coverage compared to other banks in the area. Corals observed on this bank include: *Stephanocoenia intersepta*, *Millepora alcicornis*, *Diploria strigosa*, *Montastraea cavernosa*, *Colpophyllia natans*, *Agaricia lamarcki*, and *Agaricia undata* (Schmahl et al., 2003; Schmahl and Hickerson, 2006). *Stephanocoenia intersepta* is the dominant coral in this zone. Fleshy green, brown, and red algae species including: *Dictyota pulchella*, *Lobophora variegate*, *Peyssonnelia inamoena*, *Codium isthmocladum*, *Codium interextum*, *Anadtomene lacerate*, and *Caulerpa racemosa* are abundant (Schmahl and Hickerson, 2006). Planktivorous fish such as creole fish, threadnose bass, yellow goatfish, sunshinefish, school bass, bicolor damselfish, and blue chromis dominated the fish community (Schmahl and Hickerson, 2006; Weaver et al., 2006). Deeper regions of the bank exhibit deep water corals such as antipatharians, solitary corals, and branching corals (*Oculina* and *Madrepora*) (Schmahl and Hickerson, 2006). McGrail Bank has also experienced mechanical disturbance and damage from fishing and anchoring and marine debris has been found at the bank (Schmahl and Hickerson, 2006).

Bright Bank (**Figure 4-5**) is located in deep water with its highest peak at 33 m (108 ft) below the sea surface (Robbart et al., 2009). The benthic community is dominated by a very high live cover of about 86 percent, with brown, green, and turf algae as the dominant groups. The overall coral cover of the area is about 8 percent. Bright Bank exhibits a *Stephanocoenia-Millepora* Zone with sponges and scleractinian corals (*Montastraea cavernosa*, *Stephanocoenia intersepta*, and *Diploria strigosa*) (Robbart et al., 2009; Schmahl and Hickerson, 2006). A mud volcano, drowned reef formations, and hydrocarbon seeps have also been identified on this bank (Schmahl et al., 2003). Salvage activity searching for a historic shipwreck destroyed some coral heads at this bank in the 1980's; excavation activity may have taken place as recently as 2001 (Schmahl and Hickerson, 2006).

It has been suggested that Phleger Bank be considered a sensitive offshore topographic feature. Phleger Bank (**Figure 4-5**) crests at 122 m (400 ft), deeper than the lower limit of the No Activity Zone

(85 m (279 ft) [100 m (328 ft) in the case of the Flower Gardens]). The depth of the bank precludes the establishment of the Antipatharian Zone so that even though the bank is in clear water, the biota is typical of the Nepheloid Zone (Rezak et al., 1983). The bank appears to be predominantly covered with sand, with scattered rock outcrops of approximately 1-2 m (3-7 ft) in diameter and 1 m (3 ft) in height (CSA, 1980). The sand substrate is devoid of sessile benthic organisms, although the rock outcrops support a number of epifaunal species such as cup-shaped and encrusting sponges, octocorals, and crinoids. Roughtongue bass were observed in video surveys to be the dominant fish species on this bank (CSA, 1980).

Midshelf Banks

Two midshelf banks in the CPA contain the *Millepora*-Sponge Zone: Sonnier and Fishnet Banks (**Figure 4-5**). These banks are associated with underlying salt diapirs and rise from depths of 80 m (263 ft) or less. The dominant species on these banks are hydrozoan fire corals (*Millepora*) and sponges (Rezak et al., 1983).

Sonnier Bank (**Figure 4-5**), which consists of eight peaks and banks, and has a crest at approximately 20 m (66 ft), is encrusted with fire coral (*Millepora alcicornis*) and sponges (*Neofibularia nolitangere* and *Ircina*). With depth, fire coral coverage is reduced and encrusting sponge coverage is increased (Weaver et al., 2006). A unique biological assemblage occurs at each of the peaks, which is influenced by the depths of the peak and the nepheloid layer (Weaver et al., 2006). Hermatypic anthozoan corals (*Stephanocoenia michelini*) which tolerate low light levels and moderate turbidity were reported between 36 and 41 m (Rezak et al., 1983). Planktivorous fish dominate this bank, with the most abundant species being yellowtail reeffish, creole fish, brown chromis, sunshine fish, and bluehead (Weaver et al., 2006). Angelfish, butterflyfish, damselfish, bluehead, hogfish, rock hind, grouper, Vermilion snapper, and red snapper also utilize this bank (Rezak et al., 1983). The crests of the bank were dominated by creole fish, brown chromis, bluehead, and creole wrasse and the deeper portions of the reef were dominated by tomtate, red snapper, greater amberjack, and grey triggerfish (Weaver et al., 2006). Benthic organisms occupying the turbid soft-bottom sediment at the base of the Bank include: antipatharians (*Cirrhipathes* and *Antipathes*), comatulid crinoids, sponge (*Ircinia campana*), hovering goby (*Ioglossus calliurus*), blue goby (*Ptereleotris calliurus*), tattler (*Seranus phoebe*) and large infaunal and mobile benthic species (Rezak et al., 1983; Weaver et al., 2006).

Recent Invasive Species Concerns

Two invasive species have been reported in the Gulf of Mexico: the orange cup coral (*Tubastraea coccinea*) and the lionfish (*Pterois volitans/miles*). Invasive species are organisms that are not native to the local environment and have the potential to outcompete native species. *Tubastraea coccinea*, which is reported on many oil and gas platforms in the northern Gulf of Mexico, has been reported at both Geyer and Sonnier Banks (Hickerson et al., 2008; Fenner and Banks, 2004; Sammarco et al., 2004). Over 100 colonies were reported at Geyer Bank (Hickerson et al., 2008). The lionfish was reported off the coasts of Florida, Alabama, and Louisiana in 2010 (USDOI, GS, 2010b). Reports of this species began in 2006 in Florida, but the species was confirmed in the northern Gulf of Mexico in 2010 (Schofield, 2009; USDOI, GS, 2010b). It was recently been reported in the southern Gulf of Mexico (Aguilar-Perera and Tuz-Sulub, 2010). Specific sightings were noted at Sonnier Bank and several oil and gas platforms in the CPA (USDOI, GS, 2010b).

Proposed Candidates for Threatened and Endangered Species

In 2009, a petition was submitted to NMFS by the Center for Biological Diversity to list 82 additional species of coral under the Endangered Species Act (USDOC, NOAA, 2010f). Those 82 “candidate species” are currently under review by NMFS. Some of the “candidate species” are found in the Gulf of Mexico, including *Montastraea annularis*, *Montastraea faveolata*, and *Montastraea franksi*. Once NMFS has reviewed the candidate species, a decision would be made as whether each species warrants listing under the ESA or not. If these species are listed, they would receive protection under the ESA.

Habitat Areas of Particular Concern

The NMFS has designated habitat areas of particular concern (HAPC's) within identified EFH. The HAPC's provide important habitat for federally managed fish species and are areas for conservation priorities. Designation is based on habitat ecological importance, sensitivity to fishing, sensitivity to nonfishing, developmental stress, and rarity (Dale and Santos, 2006). The only bank designated as coral HAPC in the CPA is McGrail Bank (Dale and Santos, 2006; Gulf of Mexico Fishery Management Council, 2005). Hard-bottom HAPC's in the CPA are Sonnier Bank, Geyer Bank, Bouma Bank, Rezak Bank, Sidner Bank, Alderice Bank, Jakkula Bank, and additional parts of McGrail Bank (Dale and Santos, 2006; Gulf of Mexico Fishery Management Council, 2005).

Hurricane Impacts on CPA Banks

Severe hurricanes can cause physical damage to reef structure and organisms. Banks of the GOM tend to be resilient, and damaged banks tend to recover over time, as indicated by monitoring of features, including the Sonnier, McGrail, Geyer, and Bright Banks before and after hurricanes. Long-term monitoring data from some banks in the GOM indicated that recovery observed after hurricane-induced damage agrees with historical surveys, indicating that communities are fairly resilient and stable over long periods of time (Gittings, 1998). Recovery trends have also been observed at CPA banks following hurricane damage (Robbart et al., 2009).

Baseline Conditions Following the *Deepwater Horizon* Event

It is unlikely that most of the topographic features of the CPA have been impacted by the DWH event because of their distance from the oil spill and their position on the continental shelf. The nearest protected topographic feature is Sackett Bank, which is 116 km (72 mi) from the spill site. It is possible that Sackett Bank experienced some oiling as a result of the DWH event, and this is discussed below in this chapter.. Beyond that, the next nearest feature is Diaphus Bank, approximately 240 km (150 mi) away, and it probably did not experience the possible impacts that Sackett Bank may have experienced. The bulk of the oil was dispersed in deep water off the shelf and was directed by water currents in deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008). Oil dispersed on the sea surface could have traveled onto the continental shelf, but the distance from the DWH event to protected topographic features makes it unlikely to have reached most of the banks. As a result, it is anticipated that there would be no change in existing baseline conditions to most of the bank habitats, except possibly Sackett Bank, which is discussed later. Most of the topographic features are anticipated to remain a diverse and highly productive habitat that supports a variety of coral, sponge, algal, invertebrate, and fish species.

The potential oiling footprint, as reported through the National Oceanic and Atmospheric Administration's ERMA (posted on the GeoPlatform.gov website), indicated that oil was recorded in surface waters of the CPA from approximately the western Louisiana border east to Panama City, Florida (USDOC, NOAA, 2011b). Sackett Bank appeared to be the only bank beneath the oil slick, while only small surface patches of oil were reported in water near other banks. These small patches were discontinuous and scattered (USDOC, NOAA, 2011b). The crests of the topographic features, however, are deeper than the physical mixing ability of surface oil (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Rezak et al., 1983). Also, most of the oil that migrated west in the CPA, where most of the banks are located, was primarily observed close to Louisiana's Gulf Coast, farther inshore of the banks (USDOC, NOAA, 2011b). Based on the location of the surface oil, its mixing abilities, the depth of the features, and the trajectory of the dispersed subsea plume, most of the topographic features of the CPA should not have been impacted by oil from the DWH event.

Water and sediment samples collected during and after the spill were analyzed as part of the OSAT (2010) report. A handful of samples collected off the Gulf Coast did reveal some PAH's as a result of the DWH event; however, there were no exceedances of USEPA aquatic life benchmarks measured near topographic features in either water or sediment (OSAT, 2010). There were 6 water samples out of 481 collected that exceeded the USEPA chronic toxicity benchmarks for PAH's in the offshore waters (>3 nmi offshore to the 200-m [656-ft] bathymetric contour), all of which occurred within 1 m (3 ft) of the water surface (OSAT, 2010). There were 63 water samples out of 3,605 collected from deep water (>200-m [656–ft] depth) that exceeded the USEPA aquatic life benchmarks for PAH's (OSAT, 2010).

Exceedances occurred near the water surface or in the deepwater plume within 70 km (44 mi) of the well. Oil detected in the subsurface plume was between 1,100 and 1,300 m (3,609 and 4,265 ft) and moving southwest along those depth contours (OSAT, 2010), which is deeper than the topographic features. No sediment samples collected offshore (>3 nmi offshore to the 200-m [656-ft] depth contour) and seven sediment samples collected in deep water (> 200-m [656–ft] depth) exceeded the USEPA aquatic life benchmarks for PAH exposure (OSAT, 2010). All chronic aquatic life benchmark exceedances in the sediment occurred within 3 km (2 mi) of the well, and samples fell to background levels at a distance of 10 km (6 mi) from the well (OSAT, 2010). Dispersants were also detected in waters off Louisiana, but they were below USEPA benchmarks of chronic toxicity. No dispersants were detected in sediment on the Gulf floor (OSAT, 2010). Topographic features in the CPA, therefore, are not expected to be impacted by PAH's in the water column or sediment, as they are located much farther from the well than measured benchmark exceedances.

If any impacts did occur, they would be a result of low-level or long-term exposure to dispersed, dissolved, or neutrally buoyant oil droplets. These forms of oil weathered as they traveled to the sea surface or in the subsea plume, and they became depleted in their lower molecular weight PAH's (which are the most acutely toxic components) (Brown et al., 2010; Eisler, 1987). The longer the oil spent in the water column or at the sea surface, the more diluted and weathered it became (Lehr et al., 2010). Impacts to species the oil may come in contact with may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment (Kushmaro et al., 1997; Loya, 1975 and 1976a; Rinkevich and Loya, 1977). These types of possible impacts may be investigated in future studies if deemed necessary by NRDA. It should be noted that it may be difficult to distinguish between possible low-level impacts to invertebrates as a result of exposure to DWH oil and numerous natural seeps in the CPA that are constantly releasing oil into the water (MacDonald, 2002).

Possible Impacts to Sackett Bank as a Result of the **Deepwater Horizon** *Event*

As mentioned above, Sackett Bank may have been affected by oil released during the DWH event. Sackett Bank is the nearest BOEM-protected topographic feature to the blowout; 116 km (72 mi) from the spill site. Records have indicated that Sackett Bank was beneath the surface oil slick for 11-20 days (USDOC, NOAA, 2011b). Although the crest of this bank lies at 63 m (207 ft) below the Gulf surface (Rezak et al., 1983), which is far below the depth of surface oil mixing (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002), it is 16 mi (26 km) southwest of the Mississippi Delta's Southwestern Pass, which is still within the influence of the Mississippi River's outflow. Suspended material, including sediment that flows from the Mississippi River into the Gulf and a very productive plankton community near the water's surface, supply abundant material to which oil may adhere. There is a strong possibility that the surface oil adhered to suspended material in the water column and subsequently settled over the Bank, affecting the benthic and epibenthic organisms there. Because of this potential, for purposes of this EIS, the Bureau of Ocean Energy Management is assuming this area was impacted to be conservative in this analysis and would not be essential to a reasoned choice among alternatives. In addition, there is an existing No Activity Zone around Sackett Bank that mandates OCS-energy-related, bottom-disturbing activities be located away from the bank.

Impacts to Deepwater Corals as a Result of the **Deepwater Horizon** *Event*

Although some corals on topographic features may have been impacted by oil that had adhered to organic material in the water column, as described above for Sackett Bank, or by low levels of oil in the water column, the benthic organisms on topographic features should not have been impacted, as some deepwater corals were, following the DWH event. A recent report documents damage to a deepwater (1,400-m; 4,593-ft) coral (gorgonian) community 11 km (7 mi) to the southwest of the well, in the direction of travel of the dispersed subsea oil plume. Results are still pending, but it appears that a coral community in the CPA about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged and may have been the result of contact with the dispersed subsea oil plume (Fisher, 2010a; USDOI, BOEMRE, 2010j). See **Chapter 4.2.1.10** for a detailed description of the affected deepwater coral community.

Coral communities, and other benthic organisms on the topographic features, should not have been affected by the subsea plume as the deepwater coral community was, because of topographic feature structure, location on the continental shelf, and the currents in the Gulf. Topographic features are hard substrates that rise above the seafloor, and epibenthic growth is greatest towards the peak of the structures. The DWH subsea dispersed plume traveled downslope on the seafloor, into deeper water away from the topographic features located on the continental shelf (OSAT, 2010). Therefore, the direction of travel of the plume was away from and much deeper than the growth on the topographic features. In addition, deep currents do not typically transit from deep water up onto the shelf where the topographic features are located (Pond and Pickard, 1983; Inoue et al., 2008). Based on these facts, it is unlikely that the organisms on the topographic features were exposed to the environmental conditions of the dispersed subsea plume, as the deepwater corals were.

Limited data are currently available on potential impacts of the DWH event on the topographic features in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to topographic features. Relevant data on the status of topographic features after the DWH event may take years to acquire and analyze. Much of this data is being developed through the NRDA process, which may take years to complete. Little data from the NRDA process have been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. The BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives. In the place of this incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

As a conservative approach, BOEM is assuming for purposes of this EIS that the Sackett Bank feature was likely impacted. In addition, implementation of the proposed Topographic Features Stipulation would be expected to protect sensitive habitat (including those that may have been impacted by the DWH event) from routine impacts from oil and gas production by distancing production from the protected habitat. Details of how the proposed Topographic Features Stipulation protects reefs and banks in the Gulf of Mexico from the routine and accidental impacts of petroleum production are discussed below..

4.2.1.7.2. Impacts of Routine Events

The vast majority of the Gulf of Mexico seabed is comprised of soft sediments. Topographic features formed on hard-bottom substrate are interspersed along the continental shelf above the soft sediment. These topographic features, which sustain sensitive offshore habitats in the CPA, are listed and described in **Chapter 4.2.1.7.1**.

The potential impact-producing factors on topographic features of the CPA are anchoring, infrastructure emplacement, drilling-effluent and produced-water discharges, and infrastructure removal. Impacts from accidental events such as oil spills and blowouts are discussed in **Chapter 4.2.1.7.3**. These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features in the CPA.

A Topographic Features Stipulation similar to the one described in **Chapter 2.4.1.3.1** has been included in appropriate leases since 1973 and may, at the option of the ASLM, be made a part of appropriate leases resulting from a CPA proposed action. The impact analysis of routine activities associated with a CPA proposed action presented here includes the proposed Topographic Features Stipulation. As noted in **Chapter 2.4.1.3.1**, the proposed stipulation establishes a No Activity Zone in which no bottom-disturbing activities would be allowed, and areas around the No Activity Zones (in most cases) within which shunting of drill cuttings and drilling fluids to near the bottom would be required. Clarification on how the proposed Topographic Features Stipulation applies to operators is detailed in this Agency's NTL-2009-G39 (USDOI, MMS, 2009a).

Construction Impacts on Topographic Features

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be a large threat to the biota of the offshore banks in the Gulf (Rezak and Bright, 1979; Rezak et al., 1985; Gittings et al., 1992a; Hudson et al., 1982). Anchors may break, fragment, or overturn corals and the anchor chain may drag across and catch on coral (Dinsdale and Harriott, 2004). Coral colonies may experience abrasion of tissue and skeletons, death to portions of a colony, fragmentation, or removal from substrate as a result of anchor damage (Dinsdale and

Harriott, 2004). Branching species tend to experience fragmentation while massive species incur surface damage (Marshall, 2000). Anchor damage may result in community alteration through reduced coral cover, which indirectly promotes an increase in algal cover, complete coral removal, loss of sensitive species, reduction in colony size, and a reduction in soft coral cover in heavily damaged areas (Dinsdale and Harriott, 2004). Damage as a result of anchoring in a coral community may take 10 or more years from which to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the proposed Topographic Features Stipulation, which does not allow bottom-disturbing activity.

Infrastructure emplacement and pipeline emplacement could result in suspended sediment plumes and sediment deposition on the seafloor. Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (approximately 2,000 metric tons [2,205 tons] for exploratory wells, i.e., 900 metric tons [992 tons] of drilling fluid and 1,100 metric tons [1,213 tons] of cuttings) and slightly lower discharges for development wells) (Neff, 2005), potential impacts on biological resources of topographic features could result if drill sites occur in blocks directly adjacent to No Activity Zone boundaries. Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants.

Potential construction impacts to reefs and banks can be substantially reduced by the proposed Topographic Features Stipulation, which requires all bottom-disturbing activity to be at least 152 m (500 ft) away from the boundaries of No Activity Zones. The proposed Topographic Features Stipulation limits impact through the No Activity Zone and shunting restrictions imposed within the 1,000-Meter Zone, 1-Mile Zone, 3-Mile Zone, and 4-Mile Zone.. This would prevent well drilling activities from occurring in the No Activity Zone and preclude most resuspended sediments from reaching the biota of the banks. Also, USEPA's NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone. **Chapters 3.1.1.4.1 and 4.2.1.2.2** detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. Due to the proposed Topographic Features Stipulation and USEPA discharge regulations, turbidity and smothering impacts of sessile invertebrates on topographic features caused by drilling muds and cuttings are unlikely (Neff, 2005).

The proposed Topographic Features Stipulation would protect sensitive reef species from smothering and turbidity through physical distance from drilling activities. The greatest impacts from drilling occur close to the well where a majority of the cuttings settle (Kennicutt, 1995). Reduced coral cover was reported out to 65 m (213 ft) from a well in Puerto Rico, which was probably a result of cutting deposition (Hudson et al., 1982). Corals beyond this distance did not show reduced surface cover (Hudson et al., 1982). Impacts to benthic communities as a result of drilling operations in the Gulf of Mexico are generally localized and have been reported 100-200 m (328-656 ft) from the production platform (Montagna and Harper, 1996; Kennicutt at al., 1996; Hart et al., 1989; Kennicutt, 1995; CSA, 2004b).

Differences in the dispersal patterns for well cuttings and drilling muds would result from differences in disposal methodology (surface disposal or bottom shunting). For example, well cuttings that are disposed of at the water's surface tend to disperse in the water column and are distributed widely over a large area at low concentrations (CSA, 2004b; NRC, 1983). On the other hand, cuttings that are shunted to the seafloor are concentrated over a smaller area in piles instead of being physically dispersing over wide areas (Neff, 2005). The heaviest concentrations of well cuttings and drilling fluids, for both water-based and synthetic-based drilling muds, have been reported within 100 m (328 ft) of wells and are shown to decrease beyond that distance (CSA, 2004b; Kennicutt et al., 1996). They are usually distributed unevenly and in patches, often dependent on prevailing currents (CSA, 2004b). Deeper water wells that use bottom shunting have exhibited deposition up to 500 m (1,640 ft) from a well due to the low-energy environment in deep water (Kennicutt et al., 1996). Deepwater, bottom-shunted cuttings, however, would not affect the organisms on topographic features because the cuttings are deposited on the seafloor, far below the active zone of growth on the topographic features.

Drilling fluid plumes are rapidly dispersed on the OCS where approximately 90 percent of the material discharged in drilling a well (cuttings and drilling fluid) settles rapidly to the seafloor, while 10 percent forms a plume of fine mud that drifts in the water column (Neff, 2005). The composition of muds is strictly regulated, and discharges of cuttings/muds are tested to ensure that toxicity levels are below the limits allowed by NPDES permits (USEPA, 2004, 2007c, and 2009c). Although drilling mud plumes may be visible 1 km (0.6 mi) from the discharge, rapid dilution of drilling mud plumes was reported within 6 m (20 ft) from the release point (Shinn et al., 1980; Hudson et al., 1982). Drilling muds and cuttings may be diluted 100 times at 10 m (33 ft) from the discharge and 1,000 times at 100 m (328 ft) from the discharge (Neff, 2005). Dilution continues with distance from the discharge point, and at 96 m (315 ft) from the release point, the plume was measured only a few milligrams/liter above background suspended sediment concentrations (Shinn et al., 1980).

The measured concentration of drilling mud in the water at 1 m (3 ft) from the source was far below that which caused mortality to several species of coral in bioassays (Shinn et al., 1980; Thompson et al., 1980; Raimondi et al., 1997). Concentrations of drilling muds were measured between 10.2 and 79.78 mg/L at 1 m (3 ft) from the source, which is below the concentration (100 ppm; 100 mg/L) reported to cause polyp retraction; reduced feeding; and decreased calcification, growth, respiration, photosynthesis, and NO_3 and NH_4 uptake; and possible impaired sediment rejection abilities in *Montastrea annularis* after 6-7 weeks of exposure (Shinn et al., 1980; Thompson et al., 1980; Szmant-Froelich et al., 1981; Dodge, 1982). These physiological impacts, however, sometimes led to death (Szmant-Froelich et al., 1981; Dodge, 1982). The measured concentrations are also less than those observed to cause excessive zooxanthellae loss in *Acropora cervicornis* (500 ppm) over 24 hours, death of *Paracyathus stearnsii* (200 ppm) after 6 days, reduced growth in *Montastrea annularis* over 7.5 hours (18 parts per gram in 200-mL doses, applied 2-4 mm [0.08-1.16 in] thick directly on coral), and increased oxygen consumption and ammonium excretion, reduced feeding, expulsion of photosynthetic zooxanthellae, and bacterial infections paired with algal overgrowth in *Madracis decactis* (100 ppm drilling mud enriched with ferrochrome lignosulfonate [clay thinning agent]) over 17 days (Kendall et al., 1983; Raimondi et al., 1997; Hudson and Robbin, 1980; Krone and Biggs, 1980). Coral sensitivity to drilling mud, however, is both species and drilling mud specific (Thompson and Bright, 1980). Exposures to drilling mud concentrations that result in mortality in some coral species may only cause sublethal responses or no response at all from other corals (Thompson et al., 1980).

Drilling mud concentrations at 6 m (20 ft) from the discharge were often less than those produced during storms or from boat wakes, and at 96 m (315 ft) they were less than suspended sediment concentrations measured on a windy day in coral reefs off Florida and far below concentrations measured to cause physiological impacts to corals (Shinn et al., 1980; Thompson et al., 1980; Szmant-Froelich et al., 1981; Kendall et al., 1983). The toxic effects measured as a result of exposure to drilling mud are not caused by turbidity alone but by the compounds in the drilling mud (Kendall et al., 1983). Extrapolation of data collected from bioassays indicates the no-effect concentration of drilling mud to be 3.99 ppm, which is above the average concentration of drilling mud measured in the water column 96 m (315 ft) from platforms (Kendall et al., 1983; Shinn et al., 1980). Based on those values, there should be no effects from drilling mud 96 m (315 ft) from a platform.

It is not anticipated that muds drifting in the water column would settle on or smother topographic features. The mud particles are extremely fine and would not be able to settle in the high-energy environments surrounding topographic features (Shinn et al., 1980; Hudson and Robbin, 1980). Any mud that may reach coral can be removed by the coral using tentacles and mucus secretion, and physically removed by currents that can shed the mucus-trapped particles from the coral (Shinn et al., 1980; Hudson and Robbin, 1980; Thompson et al., 1980). Considering that drilling is not allowed within 152 m (500 ft) of a No Activity Zone, that shunting to within 10 m (33 ft) of the bottom is required surrounding the No Activity Zone, and that field measurements of suspended solids far below concentrations that cause coral mortality corals 96 m (315 ft) from the discharge point (Shinn et al., 1980), corals should be distanced enough from the effects from drilling turbidity.

Due to the proposed Topographic Features Stipulation, impacts measured as a result of drilling operations would be minimal in comparison to impacts without the proposed Topographic Features Stipulation. Wells drilled in lease blocks containing topographic features would be required to shunt cuttings to within 10 m (33 ft) of the seafloor. Bottom shunting would protect the organisms on the topographic features because it results in localized deposition of cuttings at a greater depth than the biological activity of the topographic features (Neff, 2005). Therefore, the deposited material is not anticipated to reach the benthic organisms on emergent reefs. Both the distance from drilling operations and the shunting of cuttings to the seafloor are anticipated to reduce exposure pathways of drilling activities to benthic organisms on topographic features, eliminating long-term operational impacts, such as exposure to turbidity and sedimentation or associated contaminants.

Long-Term and Operational Impacts on Topographic Features

Produced waters are discharged at the water surface throughout the lifetime of the production platform and may contain hydrocarbons, trace metals, elemental sulfur, and radionuclides (Kendall and Rainey, 1991). Heavy metals enriched in the produced waters include cadmium, lead, iron, and barium (Trefry et al., 1995). Produced waters may impact both organisms attached to the production platform and benthic organisms in the sediment beneath the platform because the elements in the produced water may remain in the water column or attach to particles and settle to the seafloor (Burns et al., 1999). A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in **Chapter 4.2.1.2**.

Produced waters are rapidly diluted and impacts are generally only observed within proximity of the discharge point (Gittings et al., 1992a). Models have indicated that the vertical descent of a surface-originating plume should be limited to the upper 50 m (164 ft) of the water column, and maximum concentrations of surface plume water have been measured in the field between 8 and 12 m (26 and 39 ft) (Ray, 1998; Smith et al., 1994). Plumes have been measured to dilute 100 times within 10 m (33 ft) of the discharge and 1,000 times within 103 m (338 ft) of the discharge (Smith et al., 1994). Modeling exercises showed hydrocarbons to dilute 8,000 times within 1 km (0.6 mi) of a platform and constituents such as benzene and toluene to dilute 150,000 and 70,000 times, respectively, within that distance (Burns et al., 1999).

The less soluble fractions of the constituents in produced water associate with suspended particles and may sink (Burns et al., 1999). Particulate components were reported to fall out of suspension within 0.5-1 nmi (0.6-1.2 mi; 0.9-1.9 km) from the source outfall (Burns et al., 1999). The particulate fraction disperses widely with distance from the outfall, and soluble components dissolve in the water column, leaving the larger, less bioavailable compounds on the settling material (Burns et al., 1999). Due to the distance requirement for production platforms from topographic features, dispersion of particles in the water column, and currents around topographic features, the particulate constituents of produced waters should not impact biological communities on topographic features (Burns et al., 1999; Rezak et al., 1983; McGrail, 1982).

Waterborne constituents of produced waters can influence biological activity at a greater distance from the platform than can particulate components (Osenberg et al., 1992). The waterborne fractions travel with currents; however, data suggest that these fractions remain in the surface layers of the water column (Burns et al., 1999). Measurements of toluene, the most common dissolved hydrocarbon in produced waters, revealed rapid dilution with concentrations between 1 and 10 nanograms/liter (0.000001-0.00001 ppm) less than 2 km (1 mi) directly downcurrent from the source and rapid dispersion much closer to the source opposite the current (King and McAllister, 1998). Monitoring studies of the Flower Garden Banks located less than 2 km (1 mi) from a production platform did not indicate negative effects throughout the duration of the platform's operation, most likely due to the influence of currents (Gittings at al., 1992a). Many currents sweep around banks in the GOM instead of over them, which would protect reef organisms from contact with a produced water plume (King and McAllister, 1998; Gittings at al., 1992a; Rezak et al., 1983; McGrail, 1982). Modeling data for a platform in Australia indicated the plume to remain in the surface mixed layer (top 10 m [33 ft]) of the water column, which would further protect topographic features from produced water traveling with currents because crests of features are generally 15 m (49 ft) or more below the sea surface (Burns et al., 1999; Rezak et al., 1983).

Acute effects caused by produced waters are likely only to occur within the mixing zone around the outfall (Holdway, 2002). Past evaluation of the bioaccumulation of offshore, produced-water discharges conducted by the Offshore Operators Committee (Ray, 1998) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Possibly toxic concentrations of produced water were reported 20 m (66 ft) from the discharge in both the sediment and the water column where elevated levels of hydrocarbons, lead, and barium occurred, but no impacts to marine organisms or sediment contamination were reported beyond 100 m (328 ft) of the discharge (Neff and Sauer, 1991; Trefry et al., 1995). Another study in Australia reported that the average total concentration of 20 aromatic hydrocarbons measured in the water column 20 m (66 ft) from a discharge was less than 0.5μg/L (0.0005 mg/L or 0.0005 ppm) due to the rapid dispersion of the produced-water plume (Terrens and Tait, 1996).

Compounds found in produced waters are not anticipated to bioaccumulate in marine organisms. A study conducted on two species of mollusk and five species of fish (Ray, 1998) found that naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals. Metals including: barium, cadmium, mercury, nickel, lead, and vanadium in the tissue of the clam, *Chama macerophylla*, and the oyster, *Crassostrea virginica*, collected within 10 m (33 ft) of discharge pipes on oil platforms were not statistically different from reference stations (Trefry et al., 1995). Because high-molecular weight PAH's are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and they were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers (Ray, 1998).

Chronic effects including decreased fecundity; altered larval development, viability, and settlement; reduced recruitment; reduced growth; reduced photosynthesis by phytoplankton; reduced bacterial growth; alteration of community composition; and bioaccumulation of contaminants were reported for benthic organisms close to discharges and out to 1,000 m (3,281 ft) from the discharge (Holdway, 2002; Burns et al., 1999). Effects were greater closer to the discharges and responses varied by species. High concentrations of produced waters may have a chronic effect on corals. The Australian coral, *Plesiastrea versipora*, when exposed to 25 percent and 50 percent produced water, had a significant decrease in zooxanthellae photosynthesis and often bleached (Jones and Heyward, 2003). Experiments using WAF's of produced waters indicated that coral fertilization was reduced by 25 percent and metamorphosis was reduced by 98 percent at 0.0721 ppm total hydrocarbon (Negri and Heyward, 2000). The WAF, however, is based on a closed experimental system in equilibrium and may be artificially low for the Gulf of Mexico, which will not reach equilibrium with contaminants. The experimental value can be considered a "worst-case scenario" if the entire Gulf were to come in equilibrium with oil inputs.

Produced waters should not impact to the biota of topographic features. The greatest impacts are reported adjacent to the discharge and substantially reduced less than 100 m (328 ft) from the discharge, which is less than the 152-m (500-ft) buffer around the No Activity Zone that surrounds topographic features. Elevated concentrations of compounds measured near outfalls would not reach corals on banks in the GOM due to the high dilution rates of produced waters (King and McAllister, 1998), influence of currents around topographic features (Rezak et al., 1983; McGrail, 1982), and drilling distance required by the proposed Topographic Features Stipulation. Also, USEPA's general NPDES permit restrictions on the discharge of produced water, which require the effluent concentration 100 m (328 ft) from the outfall to be less than the 7-day "no observable effect concentration" based on laboratory exposures, would help to limit the impacts on biological resources of topographic features (Smith et al., 1994). Measurements taken from a platform in the Gulf of Mexico showed discharge to be diluted below the no observable effect concentration within 10 m (33 ft) of the discharge (Smith et al., 1994). Such low concentrations would be even further diluted at greater distances from the well.

Structure-Removal Impacts

The impacts of structure removal on soft-bottom benthic communities surrounding topographic features can include turbidity, sediment deposition, explosive shock-wave impacts, and loss of habitat. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity that could impact surrounding reef environments. Suspended sediment may evoke physiological impacts in benthic organisms, including changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus (Anchor Environmental CA, L.P., 2003) and reduced photosynthesis of coral zooxanthellae (Rogers, 1990). Long-term exposures to turbidity have even resulted in significantly reduced skeletal extension rates in the scleractinian coral *Montastraea annularis* (Torres, 2001). The higher the concentration of suspended sediment in the water column and the longer the sediment remains suspended, the greater the impact.

Sediment deposition may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, reducing light intensity, and causing physical abrasion (Wilber et al., 2005). Corals have some ability to rid themselves of some sediment through mucus production and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995). Scleractinian corals are tolerant of short-term sediment exposure and burial, but longer exposures may result in loss of zooxanthellae, polyp swelling, lesions, increased mucus production, alterations in growth rates and forms, decreased calcification, decreased photosynthesis, increased respiration, reduced areal coverage, changes in species diversity and dominance patterns, reduced recruitment, reduced reef development, and mortality (Marszalek, 1981; Rice and Hunter, 1992; Torres et al., 2001; Telesnicki and Goldberg, 1995). Coral larvae settlement may be inhibited in areas where sediment has covered available substrate (Rogers, 1990; Goh and Lee, 2008). Bleached tissue as a result of sediment exposure has been reported to recover in approximately a month (Wesseling et al., 1999).

Octocorals and gorgonians are more tolerant of sediment deposition than scleractinian corals, as they grow erect and are flexible, reducing sediment accumulation and allowing easy removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992b). Branching forms of scleractinian corals also tend to be more tolerant of sediment deposition than massive and encrusting forms (Roy and Smith, 1971). Some of the more sediment-tolerant scleractinian species in the Gulf of Mexico include *Montastraea cavernosa*, *Siderastrea siderea*, *Siderastrea radians*, and *Diploria strigosa* (Torres et al., 2001; Acevedo et al., 1989; Loya, 1976b). Corals on reefs surrounded by strong, complex currents are further protected from sedimentation because the currents prevent the settling of fine particles onto the reef (Hudson and Robbin, 1980).

The shock waves produced by the explosive structure removals may also harm benthic biota. However, corals and other sessile invertebrates have a high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure-removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs (that do not possess swim bladders), were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m (26 ft) away from the detonation of 135-kg (298-lb) charges in open water incurred a 5-percent mortality rate. Very few crabs died when exposed to 14-kg (31-lb) charges in open water 46 m (151 ft) away from the explosions. O'Keeffe and Young (1984) also described lack of damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods.

Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf: Programmatic Environmental Assessment* (USDOI, MMS, 2005) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the GOM. Impacts on the biotic communities, other than those on or directly associated with the platform, would be limited by the relatively small size of individual charges (normally 50 lb [27 kg] or less per well piling and per conductor jacket) and because BSEE regulations require charges to be detonated 5 m (16 ft) below the mudline and at least 0.9 seconds apart (to prevent shock waves from becoming additive) (USDOI, MMS, 2005). Also, because the proposed Topographic Features Stipulation precludes platform installation within 152 m (500 ft) of a No Activity Zone, adverse effects to topographic features by removal explosives should be prevented. The shock wave is significantly attenuated when explosives are buried, as opposed to detonation in the water column (Baxter et al., 1982; Wright and Hopky, 1998).

Removal of infrastructure would result in the removal of the hard substrate and encrusting community, with overall reduction in species diversity (both epifaunal encrusting organisms and the fish and large invertebrates that fed on them) with the removal of the structure (Schroeder and Love, 2004). The removal of a platform may extract a viable habitat utilized during cross pollination with a topographic feature and supported viable finfish communities. The epifaunal organisms attached to the platform that are physically removed would die once the platform is removed and disposed of. However, the seafloor habitat would return to the original soft-bottom substrate that existed before the well was drilled.

Some structures may be converted to artificial reefs. If the rig stays in place, the hard substrate and encrusting communities would remain part of the benthic habitat. The diversity of the community would not change, and associated finfish species would continue to graze on the encrusting organisms. The community would remain an active artificial reef. However, the plugging of wells and other reef in place decommissioning activities would still impact benthic communities as discussed above because all the steps for removal, except final extraction from the water, would still occur.

Proposed Action Analysis

Of 16 topographic features (shelf-edge banks and mid-shelf banks) in the CPA, 15 are found in waters less than 200 m (656 ft) deep. Geyer Bank is located at a depth of 190-210 m (623-689 ft). They represent a small fraction of the CPA. As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements; anchoring activities, and removals. Yet, operations outside the No Activity Zone could still affect topographic features through drilling effluent discharges and produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in **Chapter 4.2.1.7.3.**

For a CPA proposed action, 62-121 exploration/and 78-152 development wells are projected for offshore Subarea W0-60 (coastline to 60 m of water). There are an additional 24-46 exploration/delineation wells and 32-58 development wells proposed between 60 and 200 m (197 and 656 ft) (the boundary of the continental shelf) (**Table 3-3**). With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zone. Most drilling discharges would be shunted to within 10 m (33 ft) of the seafloor either within the 1,000-Meter Zone, 1-Mile Zone, 3-Mile Zone, or 4-Mile Zone (depending on the topographic feature) around the No Activity Zone (see **Chapter 2.4.1.3.1** for specifics). This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. Also, most studies indicate that biological impacts and sediment contamination occur within 100 m (328 ft) of production platforms (Montagna and Harper, 1996; Kennicutt at al., 1996; Neff and Sauer, 1991; Trefry et al., 1995). If drilling effluents or produced waters do reach any topographic features, concentrations of these anthropogenic influences should be diluted substantially from their initial concentration, and effects would be minimal.

For a CPA proposed action, 28-54 production structures are projected in offshore Subarea W0-60 (coastline to 60 m [197 ft] of water) and 3-6 production structures are predicted for Subarea W60-200. From 18 to 36 structure removals using explosives are projected for the Subarea W0-60 and 2-4 are projected in Subarea W60-200. The explosive removal of platforms should not impact the biota of topographic features because the proposed Topographic Features Stipulation prohibits the emplacement of platforms within 152 m (500 ft) of the No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features. Site clearance operations following a structure removal typically employ trawling the sea bottom within a radius of up to 400 m (1,320 ft) to retrieve anthropogenic debris. In areas near sensitive habitats, operators may be required to use sonar to detect debris and scuba divers to retrieve it. This precaution is exercised by BOEM as needed in the activity permitting process.

Summary and Conclusion

The proposed Topographic Features Stipulation, if applied, would prevent most of the potential impacts on topographic features from bottom-disturbing activities (structure removal and emplacement) and operational discharges associated with a CPA proposed action through avoidance, by requiring individual activities to be located at specified distances from the feature or zone. Because of the No Activity Zone, permit restrictions, and the high-energy environment associated with topographic features, if any contaminants reach topographic features they would be diluted from their original concentration and impacts that do occur would be minimal.

Effects of the Proposed Action without the Proposed Stipulation

The topographic features and associated coral reef biota of the CPA could be adversely impacted by oil and gas activities resulting from a CPA proposed action in the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected CPA topographic features. The BOEM acknowledges that impacts from routine activities without the proposed Topographic Features Stipulation could be greater for those topographic features that may have been already impacted by the DWH event.

The No Activity Zone of the topographic features would be most susceptible to adverse impacts if oil and gas activities are unrestricted without the proposed Topographic Feature Stipulation. These impacting activities could include vessel anchoring and infrastructure emplacement; discharges of drilling muds, cuttings, and produced water; and ultimately the explosive removal of structures. All the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more (Fucik et al., 1984; Rogers and Garrison, 2001). Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Such activities would physically and mechanically alter benthic substrates and their associated biota. Construction discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and interfering with larval settlement, resulting in the decrease of live benthic cover. Finally, the unrestricted use of explosives to remove platforms installed in the vicinity of or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the proposed Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms caused by depositing foreign substances onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the exclusion zones would impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations would be a further source of impact to the sensitive biological resources of the topographic features. Therefore, in the absence of the proposed Topographic Features Stipulation, a CPA proposed action could cause significant long-term (10 years or more) adverse impacts to the biota of the topographic features (Fucik et al., 1984; Rogers and Garrison, 2001).

4.2.1.7.3. Impacts of Accidental Events

The topographic features of the CPA that sustain sensitive offshore habitats are listed and described in **Chapter 4.2.1.7.1**. Refer to **Chapter 2.4.1.3.**1 for a complete description and discussion of the proposed Topographic Features Stipulation. Disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features of the CPA.

A Topographic Features Stipulation similar to the one described in **Chapter 2.4.1.3.1** has been included in appropriate leases since 1973 and may, at the option of the ASLM, be made a part of appropriate leases resulting from a CPA proposed action. Although the lease stipulation was created to protect topographic features from routine impacts of drilling and production, it also protects topographic features from accidental impacts by distancing wells from the features. The impact analysis of accidental events associated with a CPA proposed action presented here includes the proposed Topographic Features Stipulation. As noted in **Chapter 2.4.1.3.1**, the proposed stipulation establishes a No Activity Zone around topographic features, which distances these features from possible accidental impacts that could occur. Clarification on how the proposed Topographic Features Stipulation applies to operators is detailed in the NTL 2009-G39 (USDOI, MMS, 2009a).

Possible Modes of Exposure

Oil released to the environment as a result of an accidental event may impact topographic features in several ways. Oil may be physically mixed into the water column from the sea surface, be injected below the sea surface and travel with currents, be dispersed in the water column, or be adsorbed to sediment particles and sink to the seafloor. These scenarios and their possible impacts are discussed in the following sections.

An oil spill that occurs at the sea surface would result in a majority of the oil remaining at the sea surface. Lighter compounds in the oil may evaporate, and some components of the oil may dissolve in the seawater. Evaporation allows the removal of the most toxic components of the oil, while dissolution may allow bioavailability of hydrocarbons to marine organisms for a brief period of time (Lewis and Aurand, 1997). Remnants of the oil may then emulsify with water or adsorb to sediment particles and fall to the seafloor.

A spill that occurs below the sea surface (i.e., at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would result in most of the released oil rising to the sea surface. All known reserves in the Gulf of Mexico have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. As discussed in **Chapter 3.2.1.5.4**, oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column, surfacing almost directly over the source location, thus not impacting sensitive benthic communities. If the leak is deep in the water column and the oil is ejected under pressure, oil droplets may become entrained deep in the water column (Boehm and Fiest, 1982). The upward movement of the oil may be reduced if methane in the oil is dissolved at the high underwater pressures, reducing the oil's buoyancy (Adcroft et al., 2010). The large oil droplets would rise to the sea surface, but the smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010). Oil droplets less than 100 μm in diameter may remain in the water column for several months (Joint Analysis Group, 2010a). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles.

Impacts that may occur to benthic communities on topographic features as a result of a spill would depend on the type of spill, distance from the spill, relief of the biological feature, and surrounding physical characteristics of the environment (e.g., turbidity). The NTL 2009-G39 describes the proposed Topographic Features Stipulation, which requires buffers to prevent oil spills in the immediate vicinity of a topographic feature or its associated biota. This Agency has created No Activity Zones around topographic features in order to protect these habitats from disruption due to oil and gas activities. A No Activity Zone is a protective perimeter drawn around each feature that is associated with a specific isobath (depth contour) surrounding the feature in which structures, drilling rigs, pipelines, and anchoring are not allowed. These No Activity Zones are areas protected by BOEM policy. The NTL 2009-G39 recommends that drilling not occur within 152 m (500 ft) of a No Activity Zone of a topographic feature. This additional recommendation is based on essential fish habitat, and construction within the essential fish habitat would require project-specific consultation with NMFS.

Oil released during accidental events may reach topographic features. As described above, most of the oil released from a spill would rise to the sea surface and therefore reduce the amount of oil that may directly contact communities on topographic features. Small droplets of oil in the water column could possibly migrate into No Activity Zones, attach to suspended particles in the water column, and sink to the seafloor (McAuliffe et al., 1975). Topographic features and their benthic communities that are exposed to subsea plumes, dispersed oil, or oil adsorbed to sediment particles may demonstrate reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. These impacts are discussed in the following sections.

Surface Slicks and Physical Mixing

The potential of surface oil slicks to affect topographic features is limited by its ability to mix into the water column. Topographic features are high-relief protrusions above the seafloor on the continental shelf; the shallowest peaks rise to within 15 m (49 ft) of the sea surface. The two peaks of the Flower Garden Banks are the shallowest and most sensitive features, supporting true coral reefs. Other banks are deeper, supporting reef communities, but not coral reefs (**Chapter 4.2.1.7.1**). The depth of the topographic features below the sea surface helps protect benthic species from physical oil contact through distance below the sea surface. Studies have indicated that even if a surface oil slick were to occur above the topographic features, including the Flower Garden Banks, the impacts of the oil would be limited to the upper layers of the water column (Guillen et al., 1999).

Field data collected at the Atlantic entrance to the Panama Canal 2 months after a tanker spill has shown that subtidal coral species (i.e., *Porites furcata*, *Porites asteroids*, *Siderastrea radians*, and *Millepora complanata*), all of which are also present in the Gulf of Mexico, did not show measurable impacts from the oil spill, presumably because the coral was far enough below the surface oil and the oil did not contact the coral (Rützler and Sterrer, 1970). Similar results were reported from a Florida coral reef immediately following and 6 months after a tanker discharged oil nearby (Chan, 1977). The lack of acute toxicity was again attributed to the fact that the corals were completely submerged at the time of the spill and calm conditions prevented the oil from mixing into the water column (Chan, 1977).

Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10 m (33 ft). Modeling exercises have indicated that oil may reach a depth of 20 m (66 ft). Yet at this depth, the spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Therefore, depth may contribute to the protection of topographic features from physical mixing of surface oil below the sea surface. However, if dispersants are used, they would enable oil to mix into the water column and possibly impact organisms on the topographic features. Dispersants are discussed later in this section.

Subsurface Plumes

A subsurface oil spill or plume has the potential to reach a topographic feature and cause negative effects. Such impacts on the biota may have severe and long-lasting consequences, including loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success.

Topographic features are sheltered from petroleum-producing activities through stipulations written into lease sales, which distance these activities from topographic features by creating No Activity Zones around the features and placing an additional 152-m (500-ft) buffer beyond the No Activity Zone, as described in the NTL 2009-G39 (USDOI, MMS, 2009a). As distance increases, this allows for several physical and biological changes to begin to affect the oil before it reaches sensitive benthic organisms. Dilution of oil may occur as it physically mixes with the surrounding water, and some evaporation may occur. The longer and farther a subsea plume travels in the sea, the more dilute the oil would be (Vandermeulen, 1982; Tkalich and Chan, 2002). Microbial degradation of the oil would begin in the water column, reducing toxicity (Hazen et al., 2010; McAuliffe et al., 1981b). In addition, oil can adsorb to sediments in the water column and sink to the seafloor. The oil will move in the direction of prevailing currents (S.L. Ross Environmental Research Ltd., 1997); however, the reefs and banks should be physically protected because currents generally move around the topographic features, which may help sweep the subsea oil clear of the banks (Bright and Rezak et al., 1978; Rezak et al., 1983; McGrail, 1982). Also, subsea oil plumes transported by currents may not travel nearly as far as surface oil slicks because some oil droplets may conglomerate and rise or may be blocked by fronts, as was observed in the southern Gulf of Mexico during the *Ixtoc I* spill (Boehm and Fiest, 1982). Should any of the oil come in contact with adult sessile biota, effects would be primarily sublethal, as the oil would be diluted by physical and biological processes by the time it reaches the banks. Low-level exposure impacts may vary from chronic to temporary, or even immeasurable.

In the event that low concentrations of oil transported in subsea plumes reaches benthic features, coral feeding activity may be reduced. Experiments indicated that normal feeding activity of *Porites porites* and *Madracis asperula* were reduced when exposed to 50 ppm oil (Lewis, 1971). Tentacle pulsation of an octocoral, *Heteroxenia fuscescens*, has also been shown to decrease upon oil exposure, although recovery of normal pulsation was observed 96 hours after the coral was removed from the oil (Cohen et al., 1977). *Porites furcata* exposed to marine diesel and Bunker C oil reduced feeding and left their mouths open for longer than normal periods of time (Reimer, 1975).

Direct oil contact may result in coral tissue damage. Coral exposed to sublethal concentrations of oil for 3 months revealed atrophy of muscle bundles and mucus cells (Peters et al., 1981). *Porites furcata* submersed in Bunker C oil for 1 minute resulted in 100 percent tissue death (with a lag time of 114 days) (Reimer, 1975).

Reproductive ability may also be reduced if coral is exposed to oil. A hermatypic coral, *Stylophora pistillata*, and an octocoral, *Heteroxenia fuscescens*, shed their larvae when exposed to oil (Loya and Rinkevich, 1979; Rinkevich and Loya, 1977; Cohen et al., 1977). Neither of these species is present in the Gulf of Mexico, but responses may be similar in Gulf species. Undeveloped larvae exposed to oil in the water column have a reduced chance of survival due to predation (Loya and Rinkevich, 1979), which would in turn reduce the ability of larval settlement and reef expansion or recovery. A similar expulsion of gametes may occur in species that have external fertilization (Loya and Rinkevich, 1979), such as those at the Flower Garden Banks in the WPA (Gittings et al., 1992c), which may then reduce gamete survivorship due to oil exposure.

The overall ability of a coral colony to reproduce may be affected by oil exposure. Reefs of *Siderastrea siderea* that were oiled in a spill produced smaller gonads than unoiled reefs, which resulted in reproductive stress for the oiled reef (Guzmán and Holst, 1993). *Stylophora pistillata* reefs exposed to oil had fewer breeding colonies, reduced number of ovaries per polyp, and significantly reduced fecundity compared with unoiled reefs (Rinkevich and Loya, 1977). Impaired development of reproductive tissue has been reported for other reef-building corals exposed to sublethal concentrations of oil as well (Peters et al., 1981). Larvae also may not be able to settle on reefs impacted by oil. Field experiments on *Stylophora pistillata* showed reduced settlement rates of larvae on artificial substrates of oiled reefs compared with control reefs and lower settlement rates with increasing concentrations of oil in test containers (Rinkevich and Loya, 1977).

Oil exposure is believed to reduce photosynthesis and growth in corals; however, low-level exposures have produced counterintuitive and sometimes immeasurable results. Photosynthesis of the zooxanthellae in *Diploria strigosa* exposed to approximately 18-20 ppm crude oil for 8 hours was not measurably affected, although other experiments indicate that photosynthesis may be impaired at higher concentrations (Cook and Knap, 1983). A longer exposure (24 hours) of 20 mL/L (20 ppt) oil markedly reduced photosynthesis in *Stylophora pistillata*; however, concentrations of 2.5 mL/L (2.5 ppt) oil resulted in physiological stress that caused a measurable increase in photosynthesis as compared with controls (Rinkevich and Loya, 1983). Other impacts recorded include the degeneration and expulsion of photosynthetic zooxanthellae upon coral exposure to oil (Loya and Rinkevich, 1979; Peters et al., 1981). Long-term growth changes in *Diploria strigosa* that was exposed to oil concentrations up to 50 ppm for 6-24 hours did not show any measurably reduced growth in the following year (Dodge et al., 1984).

Corals exposed to subsea oil plumes may also incorporate petroleum hydrocarbons into their tissue. Records indicate that *Siderastrea siderea*, *Diploria strigosa*, *Montastraea annularis*, and *Heteroxenia fuscescens* have accumulated oil from the water column and have incorporated petroleum hydrocarbons into their tissues (Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992; Cohen et al., 1977). Hydrocarbon uptake may also modify lipid ratios of coral (Burns and Knap, 1989). If lipid ratios are modified, mucus synthesis may be impacted, adversely affecting coral ability to protect itself from oil through mucus production (Burns and Knap, 1989).

Sublethal effects, although often hard to measure, could be long lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature, extreme low tides, and diseases) (Jackson et al., 1989; Loya, 1976a). Continued exposure to oil from resuspended contaminated sediments in the area could also impact coral growth and recovery (Guzmán et al., 1994). Any repetitive or long-term oil exposure could inhibit coral larvae's ability to settle and grow, may damage coral reproductive systems, may cause acute toxicity to larvae, and may physically alter the reef interfering with larval settlement, all of which would reduce coral recruitment to an impacted area (Kushmaro et al., 1997; Loya, 1975 and 1976a; Rinkevich and Loya, 1977). Exposure of eggs and larvae to oil in the water column may reduce the success of a spawning event (Peters et al., 1997). Sublethal exposure to oil may in fact be more detrimental to corals than high concentrations of oil (Cohen et al., 1977), as sublethal concentrations are typically more widespread and have a larger overall community effect. Therefore, the sublethal effects of oil exposure, even at low concentrations, may have long-lasting effects on the community.

There was, however, a recent report that indicated damage to a deepwater coral community in the CPA (11 km [7 mi] from the Macondo well) in water far deeper than the reef organisms on the topographic features (USDOI, BOEMRE, 2010j). This deepwater coral community appears to have been impacted by contact with oil resulting from the DWH event (USDOI, BOEMRE, 2010j). See **Chapter 4.2.1.10** for a detailed description of the affected deepwater coral community. The circumstances of the deepwater coral exposure appear to be unique because the release of oil was approximately 1,500 m (4,921 ft) below the sea surface at high pressure, which caused the formation of a subsea plume of oil that was treated with dispersant, allowing it to remain at a water depth between approximately 1,100 and 1,300 m (3,609 and 4,265 ft) (Joint Analysis Group, 2010a). This 200-m (656-ft) thick subsea plume was in deep water (1,100-1,300 m [3,600-4,265 ft]) and was thought to be bounded by stratified density layers of water, allowing it to remain at depth instead of dispersing into the water column and to eventually contact the coral. This situation identified with this deepwater coral community in the CPA would not be expected to occur on the continental shelf where the topographic features are located. Stratified waters (nepheloid layer) found on the continental shelf are normally restricted to near the seafloor no more than 20 m (66 ft) up into the water column (Bright et al., 1976; Bright and Rezak, 1978). Therefore, while stratified layers in deep water may cover 200 m (656 ft) of depth, layers on the shelf would have a smaller range and oil trapped in the bottom layer would be restricted to <20 m (66 ft) above the seafloor. The reef organisms of the topographic features live above the turbid waters and, therefore, they could not be contacted by stratified oil later. Also, currents typically travel around, not over, topographic features, directing oil away from topographic highs rather than over them (Rezak et al., 1983). It is possible, however, that some of the banks with lower relief, which may frequently be covered by the nepheloid layer (Bright and Rezak, 1977), could encounter oil trapped in this density layer.

It is important to note that the lease stipulations described in NTL 2009-G39 protect topographic features from both routine and accidental impacts that may occur during petroleum production. These stipulations focus OCS activities at specified distances from the topographic features, thereby increasing the distance between the topographic features and a possible accidental event. In the case of a spill, this distance would reduce the potential for contact with the features, as the released oil would be expected to rise to the surface and disperse in the water.

Dispersed Oil

Chemically dispersed oil from a surface slick is not anticipated to result in lethal exposures to organisms on topographic features. The chemical dispersion of oil may increase the weathering process and allow surface oil to penetrate to greater depths than physical mixing would permit, and the dispersed oil generally remains below the water's surface (McAuliffe et al., 1981b; Lewis and Aurand, 1997). However, reports on dispersant usage on surface plumes indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing oil adsorbed to sediment particles traveling to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997).

Field experiments designed to test dispersant use on oil spills reported dispersed oil concentrations between 1 and 3 ppm, 9 m (26 ft) below the sea surface, approximately 1 hour after treatment with dispersant (McAuliffe et al., 1981a and 1981b). Other studies indicated that dispersed oil concentrations were <1 ppm, 10 m (33 ft) below the sea surface (Lewis and Aurand, 1997). The biological impacts that may occur from dispersant usage are greatest within the first hour of application and occur primarily to organisms living near the water's surface (Guillen et al., 1999). The above data indicate that the mixing depth of dispersed oil is less than the depths of the crests of topographic features (greater than 15 m [49 ft] below the sea surface), greatly reducing the possibility of exposure to dispersed surface oil.

Any dispersed surface oil that may reach the benthic communities of topographic features in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a). Such concentrations would not be life threatening to larval or adult stages, based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

The use of dispersants near or above protected features, such as the Flower Garden Banks or other topographic features, could result in impacts to the features because dispersants allow floating oil to mix with water. The Flower Gardens Oil Spill Mitigation Workgroup discourages the use of dispersants near the Flower Garden Banks, especially from May to September when coral is spawning (Guillen et al., 1999). Mechanical oil cleanup is suggested during this time of year because coral larvae is sensitive to dispersants and the sea state is calm, allowing for mechanical removal (Guillen et al., 1999). The Flower Garden Banks National Marine Sanctuary helped to develop a regional response plan for dispersant use near the sanctuary using literature, field observations, and spill risk assessments (Gittings, 2006). Results of the investigations led to a NOAA policy revision in 1994 that allowed dispersant use if the Federal On-Scene Coordinator deems it appropriate; however, the Flower Garden Banks National Marine Sanctuary requests that dispersant application be as far as possible from the sanctuary and not occur during seasonal species gatherings or spawning. Also, the Sanctuary's management must be consulted and forwarded incident relevant data (Gittings, 2006). The distancing of the dispersant application from the Flower Garden Banks National Marine Sanctuary would allow for dilution of the compounds in the surrounding water column away from protected habitat. However, as stated above, the use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis.

Dispersants that are used on oil below the sea surface can travel with currents through the water and may contact benthic organisms on the topographic features. If the oil spill occurs near a topographic feature, the dispersed oil could be concentrated enough to harm the community. However, the longer the oil remains suspended in the water column traveling with currents, the more dispersed it would become. Weathering would also be accelerated and biological toxicity reduced (McAuliffe et al., 1981b). Although the use of subsea dispersants is a new technique and very little data are available on dispersion rates, it is anticipated that any oil that could reach topographic features would be in low concentration based on surface slick dilution data (McAuliffe et al., 1981a; Lewis and Aurand, 1997). Currents around the topographic features may sweep the subsea oil clear of the features, as bottom currents typically travel around topographic highs rather than over them (Rezak et al., 1983). As discussed above, recent data from studies of the DWH event and resulting spill showed that oil treated with dispersant at depth remained at a water depth between 1,100 and 1,300 m (3,609 and 4,265 ft), bounded by stratified density layers of water (Joint Analysis Group, 2010a). Stratification on the continental shelf, such as that observed in the turbid nepheloid layer, is normally restricted to the seafloor, no more than 20 m (66 ft) up into the water column (Bright et al., 1976; Bright and Rezak, 1978). So, while stratified layers in deep water may cover 200 m (656 ft) of depth, layers on the shelf have a smaller range and oil trapped in the bottom layer may be restricted to less than 20 m (66 ft) above the seafloor. Unusual circumstances, such as mixing resulting from passage of a hurricane, may change this situation somewhat, causing subsea oil plumes to mix through the entire water column. However, such mixing would also serve to reduce the concentration of toxic components. Therefore, impacts resulting from exposure to dispersed oil are anticipated to be sublethal for communities on topographic features. In some cases, less diverse communities at the base of topographic features could experience lethal contact with subsea oil plumes if the source of the spill is nearby on the seafloor.

Sublethal impacts that may occur to coral exposed to dispersed oil may include reduced feeding and photosynthesis, reduced reproduction and growth, physical tissue damage, and altered behavior. Short-term, sublethal responses of *Diploria strigosa* were reported after exposure to dispersed oil at a concentration of 20 ppm for 24 hours (Knap et al., 1983; Wyers et al., 1986). Although concentrations in this experiment were higher than what is anticipated for dispersed oil at depth, effects included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, localized tissue rupture (Wyers et al., 1986), and a decline in tentacle expansion behavior (Knap et al., 1983). Normal behavior resumed within 2 hours to 7 days after exposure (Wyers et al., 1986; Knap et al., 1983). This coral, however, did not show indications of stress when exposed to 1 ppm and 5 ppm of dispersed oil for 24 hours (Wyers et al., 1986). *Diploria strigosa* exposed to dispersed oil (20:1, oil:dispersant) showed an 85 percent reduction in zooxanthellae photosynthesis after 8 hours of exposure to the mixture (Cook and Knap, 1983). However, the response was short-term, as recovery occurred between 5 and 24 hours after exposure and return to clean seawater. Investigations 1 year after *Diploria strigosa* was exposed to concentrations of dispersed oil between 1 and 50 ppm for periods between 6 and 24 hours did not reveal any impacts to growth (Dodge et al., 1984; Knap et al., 1983). It should be noted, however, that subtle growth effects may have occurred but were not measurable (Knap et al., 1983).

Historical studies indicate that dispersed oil appeared to be more toxic to coral species than oil or dispersant alone. The greater toxicity may be a result of an increased number of oil droplets, resulting in a greater contact area between the dispersed oil and water (Elgershuizen and De Kruijf, 1976). The dispersant results in a higher water-soluble fraction of oil contacting the cell membranes of the coral (Elgershuizen and De Kruijf, 1976). The mucus produced by coral, however, can protect an organism from oil. Both hard and soft corals have the ability to produce mucus, and mucus production has been shown to increase when corals are exposed to crude oil (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Dispersed oil, which has very small oil droplets, does not appear to adhere to coral mucus, and larger untreated oil droplets may become trapped by the mucus barrier (Knap, 1987; Wyers et al., 1986). However, entrapment of the larger oil droplets may increase long-term exposure to oil if the mucus is not shed in a timely manner (Knap, 1987; Bak and Elgershuizen, 1976).

More recent field studies did not reveal as great an impact of dispersants on corals as were indicated in historical toxicity tests (Yender and Michel, 2010). This difference in reported damage probably resulted from a more realistic application of dispersants in an open field system and because newer dispersants are less toxic than the older ones (Yender and Michel, 2010). Field studies have shown oil to be dispersed to the part per billion level minutes to hours after the dispersant application, which is orders of magnitude below the reasonable effects threshold of oil in the water column (20 ppm) measured in some studies (McAuliffe, 1987; Shigenaka, 2001).

Although dispersed oil may be toxic to corals during some exposure experiments (Shafir et al., 2007; Wyers et al., 1986; Cook and Knap, 1983), untreated oil may remain in the ecosystem for long periods of time, while dispersed oil does not (Baca et al., 2005; Ward et al., 2003). Twenty years after an experimental oil spill in Panama, oil and impacts from untreated oil were still observed at oil treatment sites, but no oil or impacts were observed at dispersed oil or reference sites (Baca et al., 2005). Long-term recovery of the coral at the dispersed oil site had already occurred as reported in a 10-year monitoring update, and the site was not significantly different from the reference site (Ward et al., 2003).

The time of year and surrounding ecosystem must be considered when determining if dispersants should be used. Dispersant usage may result in reduced or shorter term impacts to coral reefs; however, it may increase the impacts to other communities, such as mangroves (Ward et al., 2003). Therefore, dispersant usage may be more applicable offshore than in coastal areas where other species may be impacted as well. In addition, dispersant use may be restricted in some areas during peak coral spawning periods (e.g., August-September for major reef-building species) (Gittings et al., 1992c and 1994) in order to limit the impacts of oil pollution on the near-surface portion of the water column.

Oil Adsorbed to Sediment Particles

Smaller suspended oil droplets could be carried to the seafloor as a result of oil droplets adhering to suspended particles in the water column. Smaller particles have a greater affinity for oil (Lewis and Aurand, 1997). Oil may also reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Oiled sediment that settles to the seafloor may affect organisms attached to topographic features. It is anticipated that the greatest amount of oil adsorbed to sediment particles would occur close to the spill, with lesser concentrations farther from the source. Studies after a spill that occurred at the Chevron Main Pass Block 41C Platform in the northern Gulf of Mexico revealed that the highest concentrations of oil in the sediment were close to the platform and that the oil settled to the seafloor within 5-10 mi (8-16 km) of the spill site (McAuliffe et al., 1975). Therefore, if the spill occurs close to a topographic feature, the underlying benthic communities may become smothered by the particles and exposed to toxic hydrocarbons. However, because of the implementation of the No Activity Zone and surrounding 152-m (500-ft) buffer zone, topographic features should be distanced from the heaviest oiled sedimentation effects. Oiled sediment depositional impacts, however, are possible and may smother nearby benthic species.

Some oiled particles may become widely dispersed as they travel with currents while they settle out of suspension. Settling rates are determined by size and weight of the particle, salinity, and turbulent mixing in the area (Poirier and Thiel, 1941; Bassin and Ichiye, 1977; Deleersnijder et al., 2006). Because particles would have different sinking rates, the oiled particles would be dispersed over a large area, most likely at sublethal or immeasurable levels. Studies conducted after the *Ixtoc* oil spill revealed that although oil was measured on particles in the water column, measurable petroleum levels were not found in the underlying sediment (ERCO, 1982). Based on BOEM’s restrictions and the settling rates and behavior of oil attached to sediment particles, the majority of organisms that may be exposed to oil adsorbed to sediment particles are anticipated to experience low-level concentrations.

Some oil, however, could reach topographic features as particles with adhered oil settle out of the water column. Sublethal impacts to benthic organisms from such exposure may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. Experiments have shown that the presence of oil on available substrate for larval coral settlement has inhibited larval metamorphosis and larval settlement in the area (Kushmaro et al., 1997). Crude oil concentrations as low as 0.1 ppm on substrate upon which the coral larvae were to settle reduced larval metamorphosis occurrences by 50 percent after 8 days of exposure. Oil concentrations of 100 ppm on substrates resulted in only 3.3 percent of the test population metamorphosizing (Kushmaro et al., 1997). There were also an increased number of deformed polyps after metamorphosis due to oil exposure (Kushmaro et al., 1997). It is also possible that recurring exposure may occur if oil adsorbed to sediment particles is resuspended locally, possibly inhibiting coral growth and recovery in the affected areas (Guzmán et al., 1994). Oil stranded in sediment is reportedly persistent and does not weather much (Hua, 1999), so coral may be repeatedly exposed to low concentrations of oil.

Adult coral, however, may be able to protect itself from low concentrations of oil adsorbed to sediment particles by production and sloughing of mucus. Coral mucus may act as a barrier to protect coral from the oil in the water column, and it has been shown to aid in the removal of oiled sediment on coral surfaces (Bak and Elgershuizen, 1976). Corals may use a combination of increased mucus production and ciliary action to rid themselves of oiled sediment (Bak and Elgershuizen, 1976).

Blowout and Sedimentation

Oil or gas well blowouts are possible occurrences in the OCS. Benthic communities on topographic features exposed to large amounts of resuspended sediments following a subsurface blowout could be subject to sediment suffocation, exposure to toxic contaminants, and reduced light. Should oil or condensate be present in the blowout flow, liquid hydrocarbons could be an added source of negative impact on the organisms.

Turbid waters have less light penetrating to depth, which may result in reduced photosynthesis by the symbiotic zooxanthellae that live in hermatypic coral tissue (Rogers, 1990). Long-term exposures to turbidity have even resulted in significantly reduced skeletal extension rates in the scleractinian coral *Montastraea annularis* (Torres, 2001; Dodge et al., 1974) and an acute decrease in calcification rates of *Madracis mirabilis* and *Agaricia agaricites* (Bak, 1978). The higher the concentration of suspended sediment in the water column and the longer the sediment remains suspended, the greater the impact.

Suspended sediment that is transported by currents deep in the water column should not impact the benthic organisms on the upper portions of topographic features. Studies have shown that deep currents sweep around topographic features instead of over them, allowing the suspended sediment to remain at depth (Rezak et al., 1983; McGrail, 1982). Therefore, suspended sediment from depth should not be deposited on top of the elevated benthic organisms. Organisms on the lower levels around topographic features are frequently enveloped in a turbid nepheloid layer; organisms surviving here are tolerant of heavy turbidity.

Sediment that settles out of upper layers of the water column may impact benthic organisms of topographic features. Sediment deposition may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, reducing light intensity, and causing physical abrasion (Wilber et al., 2005). Corals may experience reduced colony coverage, changes in species diversity and dominance patterns, alterations in growth rates and forms, decreased calcification, decreased photosynthesis, increased respiration, increased production in mucus, loss of zooxanthellae, lesions, reduced recruitment, and mortality (Torres et al., 2001; Telesnicki and Goldberg, 1995). Coral larvae settlement may also be inhibited in areas where sediment has covered available substrate (Rogers, 1990; Goh and Lee, 2008).

Impacts to corals as a result of sedimentation would vary based on coral species, the height to which the coral grows, degree of sedimentation, length of exposure, burial depth, and the coral's ability to clear the sediment. Impacts may range from sublethal effects such as reduced growth, alteration in form, reduced recruitment and productivity, and slower growth to death (Rogers, 1990).

Corals have some ability to rid themselves of sediment through mucus production and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995). Scleractinian corals are tolerant of short-term sediment exposure and burial, but longer exposures may result in loss of zooxanthellae, polyp swelling, increased mucus production, reduced coral growth, and reduced reef development (Marszalek, 1981; Rice and Hunter, 1992). Bleached tissue as a result of sediment exposure has been reported to recover in approximately a month (Wesseling et al., 1999).

Solitary octocorals and gorgonians, which are found on many hard-bottom features, are more tolerant of sediment deposition than colony-forming scleractinian corals because the solitary species grow erect and are flexible, reducing sediment accumulation and allowing easy removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992b). Branching and upright forms of scleractinian corals, such as *Madracis mirabilis* and *Agaricia agaricites*, also tend to be more tolerant of sediment deposition than massive, plating, and encrusting forms, such as *Porites astreoides* (Roy and Smith, 1971; Bak, 1978). Some of the more sediment tolerant scleractinian species in the Gulf of Mexico include *Montastraea cavernosa*, *Siderastrea siderea*, *Siderastrea radians*, and *Diploria strigosa* (Torres et al., 2001; Acevedo et al., 1989; Loya, 1976b).

Since the BOEM-proposed stipulation would preclude drilling within 152 m (500 ft) of the No Activity Zone, most adverse effects on topographic features from blowouts would be prevented. Petroleum-producing activities would be far enough removed that heavy layers of sediment that may become resuspended as a result of a blowout should settle out of the water column before they reach sensitive biological communities. Other particles that travel with currents should become dispersed as they travel, reducing turbidity or depositional impacts. Furthermore, sediment traveling at depth should remain at depth instead of rising to the top of topographic features.

Response Activity Impacts

Oil-spill-response activity may also affect sessile benthic communities on topographic features. Booms anchored to the seafloor are sometimes used to control the movement of oil at the water surface. Boom anchors can physically damage corals and other sessile benthic organisms, especially when booms are moved around by waves (Tokotch, 2010). Vessel anchorage and decontamination stations set up during response efforts may also break or kill hard-bottom features as a result of setting anchors. Spill response, especially in the case of a catastrophic spill, can involve activity by varied organizations, including many that are not coordinated by the oil-spill-response plan. While the spill-response plan and activities coordinated by responsible agencies such as NOAA and USCG would avoid damaging sensitive habitats, the risk remains that some other responders may not be aware of all the sensitive habitats of concern. Injury to coral reefs as a result of anchor contact may result in long-lasting damage or failed recovery (Rogers and Garrison, 2001). Effort should be made to keep vessel anchorage areas far from sensitive benthic features to minimize impact.

Drilling muds comprised primarily of barite may be pumped into a well to stop a blowout. If a “kill” is not successful, the mud may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on the BOEM’s proposed stipulation (described in NTL 2009-G39), a well should be far enough away from topographic features to prevent extruded drilling muds from smothering sensitive benthic communities. It is more likely that benthic organisms on topographic features would experience turbidity or light layers of sedimentation due to a blowout based on the distance requirements of bottom-disturbing activity written in BOEM’s proposed stipulations. Turbidity impacts may result in reduced photosynthesis or growth (Rogers, 1990; Torres, 2001). Light layers of deposited sediment would most likely be removed by mucus and ciliary action (Marszalek, 1981; Bak and Elgershuizen, 1976; Telesnicki and Goldberg, 1995).

Proposed Topographic Features Stipulation

The proposed Topographic Features Stipulation would preclude drilling within 152 m (500 ft) of a topographic feature’s No Activity Zone to prevent adverse effects from nearby drilling. The BOEM has created a No Activity Zone around topographic features in order to protect these habitats from routine activity disruption due to oil and gas activities. The No Activity Zone also creates a buffer between drilling activity and sensitive organisms. Although the buffer was created to distance routine oil and gas activity from topographic features, it also provides some protection from an accidental event. For example, if a blowout were to occur at a well, a majority of the oil would rise to the water’s surface before it traveled horizontally toward a topographic feature. The surface oil would then float above the features, substantially reducing the possibility of physical oiling due to the distance of the features below the water’s surface and physically mixing ability of oil into the water column (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Guillen et al., 1999). The oil should remain above the zones of active biologic growth provided that dispersants are not used near the topographic features. The Flower Gardens Oil Spill Mitigation Workgroup, for example, discourages the use of dispersants near the Flower Garden Banks, especially from May to September when coral is spawning (Guillen et al., 1999). However, the use of dispersants near protected features is left to the discretion of the Federal On-Scene Coordinator on a case-by-case basis

Although BOEM’s proposed stipulation prevents oil and gas drilling activity within 152 m (500 ft) of the No Activity Zone of topographic features, some sublethal effects may occur to benthic organisms as a result of an oil spill, despite this 152-m (500-ft) buffer. Sublethal impacts may include exposure to low levels of oil, dispersed oil, oil adsorbed to sediment particles, and turbidity and sedimentation from disturbed sediments. Impacts from these exposures may include reduced photosynthesis, reduced growth, altered behavior, decreased community diversity, altered community composition, reduction in coral cover, and reduced reproductive success. The severity of these impacts may depend on the concentration and duration of exposure.

Proposed Action Analysis

Accidental releases of oil could occur as a result of a CPA proposed action. Small spills (0-1 bbl) would have the greatest number of occurrences (**Table 3-12**). Estimates of the number of small-scale releases as a result of a CPA proposed action ranges from 929 to 1,806 spills. These spills would be small in volume and rapidly diluted by surrounding water. A large-scale spill, ≥1,000 bbl, is very unlikely and, based on historical spill rates and projected production for a CPA proposed action, up to 1 spill of this volume is expected to occur as a result of a CPA proposed action. If a large-scale release of oil were to occur, impacts would be more widely spread.

The probability of surface water oiling occurring as a result of a CPA proposed action anywhere between the shoreline and the 300-m (984-ft) depth contour, which is where the topographic features are located, was estimated by the Bureau of Ocean Energy Management's OSRA model for spills ≥1,000 bbl. For surface waters of the Louisiana West of Mississippi River polygon, the OSRA model estimated probabilities of 24-41 percent and 28-45 percent after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**).

The probabilities of oil contacting the surface water above HAPC's in the CPA, including Sonnier Bank, are much lower than the probabilities predicted for the 20- to 300-m (66- to 984-ft) depth contour polygons (**Figure 3-25**). The probability of a spill originating from a CPA proposed action and contacting the surface waters of Sonnier Bank was <0.5 percent to 1 percent after 10 and 30 days, respectively (**Figure 3-25**).

All of the topographic features in the CPA are found in water depths less than 200 m (656 ft). They represent a small fraction of the continental shelf area in the CPA. The fact that the topographic features are widely dispersed, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to the topographic features.

The proposed Topographic Features Stipulation (**Chapter 2.4.1.3.1**) would assist in preventing most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of topographic features. However, operations outside the No Activity Zone (including blowouts and oil spills) may still affect topographic features.

The depth below the sea surface to which many topographic features rise helps to protect them from surface oil spills. Any oil that might be driven to 15 m (49 ft) or deeper would probably be at concentrations low enough to result in a limited impact to these features. Also, the low probabilities of oil reaching the surface waters above these banks, based on the OSRA model, combined with the limited depth of the mixing of surface oil to the crests of these features, function to protect these features.

A subsurface spill or plume may impact sessile biota of topographic features. Oil or dispersed oil may cause sublethal impacts to benthic organisms if a plume reaches these features. Impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. The proposed Topographic Features Stipulation would limit the potential impact of such occurrences by keeping the sources of such adverse events geographically removed from the sensitive biological resources of topographic features. Other policies, such as the one implemented by NOAA for the Flower Gardens National Marine Sanctuary, requires dispersants to be applied as far from the Flower Garden Banks as possible.

Oil adsorbed to sediments or sedimentation as a result of a blowout may impact benthic organisms. However, the proposed Topographic Features Stipulation places petroleum-producing activity at a distance from topographic features, resulting in reduced turbidity and sedimentation, and any oil adsorbed to sediments should be well dispersed, resulting in a light layer of deposition that would be removed by the normal self-cleaning processes of benthic organisms.

Summary and Conclusion

The proposed Topographic Features Stipulation, if applied, would assist in preventing most of the potential impacts on topographic feature communities from blowouts, surface, and subsurface oil spills and the associated effects by increasing the distance of such events from the topographic features. It would be expected that the majority of oil would rise to the surface and that the most heavily oiled sediments would likely be deposited before reaching the topographic features. Any contact with spilled oil would likely cause sublethal effects to benthic organisms because the distance of activity would prevent contact with concentrated oil. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal and impacts would be at the community level. Any turbidity, sedimentation, and oil adsorbed to sediments would also be at low concentrations by the time the topographic features were reached, also resulting in sublethal impacts. Impacts from an oil spill on topographic features are also lessened by the distance of the spill to the features, the depth of the features, and the currents that surround the features.

Effects of the Proposed Action without the Proposed Stipulation

The topographic features and associated coral reef biota of the CPA could be damaged by oil and gas activities resulting from a CPA proposed action should they not be restricted by application of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected topographic features. The area within the No Activity Zone would probably be the areas of the topographic features that are most susceptible to adverse impacts if oil and gas activities are unrestricted by the proposed Topographic Features Stipulation. These impacting factors would include blowouts, surface oil spills, and subsea oil spills, along with oil-spill-response activities such as the use of dispersants. Potential impacts from routine activities resulting from a CPA proposed action are discussed in **Chapter 4.2.1.7.2**.

Oil spills as well as routine activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone if the proposed Topographic Features Stipulation is not applied. Direct oil contact may result in acute toxicity (Dodge et al., 1984; Wyers et al., 1986). In most cases, recovery from disturbances would take 10 years or more (Fucik et al., 1984; Rogers and Garrison, 2001). The use of dispersants near or above protected features, such as the topographic features, could result in impacts to the features because dispersants allow floating oil to mix with water. Nevertheless, it is up to the sole discretion of the Federal On-Scene Coordinator on whether dispersants would be used near topographic features during an accidental event.

Disturbances, including oil spills and blowouts, could alter benthic substrates and their associated biota over large areas. In the unlikely event of a blowout, sediment resuspension potentially associated with oil could cause adverse turbidity and sedimentation conditions. In addition to affecting the live cover of a topographic feature, a blowout could alter the local benthic morphology, thus irreversibly altering the reef community. Oil spills (surface and subsea) could be harmful to the local biota should the oil have a prolonged or recurrent contact with the organisms. Accidental events related to a CPA proposed action could cause significant long-term (10 years or more) adverse impacts to the biota of the topographic features.

4.2.1.7.4. Cumulative Impacts

The proposed Topographic Features Stipulation is assumed to be in effect for this cumulative analysis because the stipulation has been included in appropriate OCS leases since 1973 to protect topographic features. The continued application of this proposed stipulation would prevent any direct adverse impacts on the biota of the topographic features, i.e., impacts potentially generated by oil and gas operations. The cumulative impact from routine oil and gas operations includes effects resulting from a CPA proposed action, as well as those resulting from past and future OCS leasing. These operations include anchoring, structure emplacement, muds and cuttings discharge, effluent discharge, blowouts, oil spills, and structure removal. Potential non-OCS-related factors include vessel anchoring, treasure-hunting activities, import tankering, heavy storms and hurricanes, the collapse of the tops of the topographic features due to dissolution of the underlying salt structure, commercial fishing, and recreational scuba diving.

Mechanical damage, including anchoring, is considered to be a catastrophic threat to the biota of topographic features. Detrimental impacts would result if oil and gas operators anchored pipeline barges, drilling rigs, and service vessels or if they placed structures on topographic features (Rezak and Bright, 1979; Rezak et al., 1983). The proposed Topographic Features Stipulation (**Chapter 2.4.1.3.1**) restricts these activities within 152 m (500 ft) of the No Activity Zone around topographic features, thus preventing adverse impacts on benthic communities of topographic communities (USDOI, MMS, 2009a).

The proposed Topographic Features Stipulation would protect topographic features by mandating a physical distance from drilling activities. Drilling fluid plumes are rapidly dispersed on the OCS; approximately 90 percent of the material discharged in drilling a well (cuttings and drilling fluid) settles rapidly to the seafloor, while 10 percent forms a plume of fine mud that drifts in the water column (Neff, 2005). Shunting of drill muds and cutting to within 10 m (33 ft) of the seabed is required for wells drilled in the vicinity of topographic features. Shunting restricts the cuttings to a smaller area and places the turbidity plume near the seafloor where the environment is frequently turbid and benthic communities are adapted to high levels of turbidity. Water currents moving turbidity plumes across the seafloor would sweep around topographic features rather than carrying the turbidity over the banks (Bright and Rezak, 1978). Any sediment that may reach coral can be removed by the coral using tentacles and mucus secretion, and physically removed by currents that can shed the mucus-trapped particles from the coral (Shinn et al., 1980; Hudson and Robbin, 1980).

The USEPA, through its NPDES discharge permit, also enacts further mitigating measures on discharges. As noted in **Chapter 4.2.1.7.2** above, drilling fluids can be moderately toxic to marine organisms (the more toxic effluents are not allowed to be discharged under NPDES permits), and their effects are restricted to areas closest to the discharge point, thus preventing contact with the biota of topographic features (Montagna and Harper, 1996; Kennicutt et al., 1996). Small amounts of drilling effluent in low concentrations may reach a bank from wells outside the No Activity Zone; however, these amounts, if measurable, would be extremely small and would have minimal effects on the biota.

With the inclusion of the proposed Topographic Features Stipulation, no discharges of produced water would take place within the No Activity Zone. The rapid dispersion of produced waters into the surrounding waters, combined with USEPA's discharge regulations and permits, should eliminate the threat of discharges reaching and affecting the biota of a topographic high. Any impacts that these discharges could cause would be primarily sublethal, and interference to the general ecosystem performance should occur.

Impacts on the topographic features could occur as a result of oil- and gas-related spills or spills from import tankering. Due to dilution and physical mixing depths of surface oil paired with the depths of the crests of the topographic features, discharges should not reach topographic features in sufficient concentrations to cause impacts. Tanker accidents would result in surface oil spills, which generally do not mix below a depth of 10-20 m (33-66 ft) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002), which should protect most topographic features, very few of which rise to within 15 m (50 ft) of the sea surface. Any dispersed surface oil from a tanker spill that may reach the benthic communities of topographic features in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations would not be life threatening to larval or adult stages based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed or physically mixed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Potential blowouts could impact the biota of the topographic features. Based on the proposed Topographic Features Stipulation, few blowouts, if any, would reach the No Activity zone around the topographic features. The proposed stipulation creates a buffer zone around the banks; this buffer zone would protect the banks from direct impacts by damaging amounts of suspended sediment from a seafloor blowout. Most of the oil from a seafloor blowout would rise to the surface, but some of it may be entrained in the water column as a subsea plume. Oil in a subsea plume could be carried to a topographic feature. The resulting level of impacts depends on the concentration of the oil when it contacts the habitat. The farther the blowout is from the topographic feature, the more dispersed the oil and sediment would become, reducing the possible impacts. Also, because currents sweep around topographic features instead of over them, subsea oil should be directed away from the more sensitive communities on the upper levels of topographic features (Rezak et al., 1983; McGrail, 1982). If oil were to contact the topographic features, the impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. In the highly unlikely event that oil from a subsurface spill could reach the peaks of topographic features in lethal concentrations, the recovery of this area could take in excess of 10 years (Fucik et al., 1984).

The cumulative impact of the possibility of a future oil spill along with the DWH event is anticipated to be extremely small. It is highly unlikely that most of the topographic features of the CPA were impacted by the DWH event because of their distance from the blowout. The bank that was closest to the spill, Sackett Bank, may have been impacted by oil that adhered to organic material settling out of the water column onto the bank. This bank, however, should not have experienced physical oiling because it has a crest 63 m (207 ft) below the surface, far below the physical mixing depth of oil. If any impacts did occur to the other topographic features in the CPA, they were sublethal and may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. These impacts, if they occurred, may be difficult to measure.

Platforms would be removed from the OCS Program each year; some may be in the vicinity of topographic features (**Table 3-3**). However, the proposed Topographic Features Stipulation prevents the installation of platforms near the No Activity Zone, thus reducing the potential for impact from platform removal. The explosive removals of platforms are far enough away to prevent impacts to the biota of the topographic features.

Non-OCS Leasing Impacts

Although the Topographic Features Stipulation prohibits oil and gas leaseholders from anchoring vessels and placing structures within 152 m (500 ft) of the No Activity Zone around topographic features, the stipulation does not affect other non-OCS activities such as anchoring, fishing, or recreational scuba diving, or anchoring other vessels on or near these features. Many of the topographic features are found near established shipping fairways and are well-known fishing areas. Also, several of the shallower topographic features are frequently visited by scuba divers aboard recreational vessels (Hickerson et al., 2008). Anchoring at a topographic feature by a vessel involved in any of these activities could damage the biota. The degree of damage would depend on the size of the anchor and chain (Lissner et al., 1991). Anchor damages incurred by benthic organisms may take more than 10 years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001).

The use of explosives in treasure-hunting operations has become a concern on topographic features; several large holes and damage have occurred on Bright Bank and treasure hunters have damaged the bank as recently as 2001 (Schmahl and Hickerson, 2006). The blasting of large areas of Bright Bank by treasure hunters has resulted in the loss of extensive live coral cover (Schmahl and Hickerson, 2006). The recovery from such destructive activity may take in excess of 10 years (Fucik et al., 1984; Rogers and Garrison, 2001). Recovery of the system to pre-interference conditions would depend on the type and extent of damage incurred by individual structures.

Impacts from natural occurrences such as hurricanes occasionally result in damage to the biota of the topographic features. Hurricane Rita caused severe damage to Sonnier Bank (Robbart et al., 2009). Live cover was reduced at this bank and the disappearance of the sponge colonies, *Xestospongia muta*, was notable (Robbart et al., 2009). The community structure had visibly changed from pre-Hurricane Rita (2004) studies at this bank (Kraus et al., 2006 and 2007). In 2006, the habitat was dominated by algae, indicating an alteration in habitat after Hurricane Rita (Kraus et al., 2007). The algal cover, however, was the beginning of recovery of the storm-impacted areas, which was further colonized with sponges (Robbart et al., 2009). Fish community shifts were also observed on Sonnier Bank after Hurricane Rita versus before the storm, but clear links have yet to be made to the storm (Kraus et al., 2007). Hurricane Katrina may have caused similar damage on other topographic features. Another possible natural impact to the banks would be the dissolution of the underlying salt structure, leading to collapse of the reef (Seni and Jackson, 1983). Dissolution of these salt structures is unlikely.

Depending on the levels of fishing pressure exerted, fishing activities that occur at the topographic features may impact local fish populations. The collecting activities by scuba divers on shallow topographic features may have an adverse impact on the local biota. Anchoring during recreational and fishing activities, however, would be the source of the majority of severe impacts incurred by the topographic features.

Summary and Conclusion

Activities causing mechanical disturbance represent the greatest threat to the topographic features. With respect to OCS leasing related activities, this would, however, be prevented by the continued application of the proposed Topographic Features Stipulation. Potential OCS-related impacts include anchoring of vessels and structure emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal.

The proposed Topographic Features Stipulation would preclude mechanical damage caused by oil and gas leaseholders from impacting the benthic communities of the topographic features and would protect them from operational discharges by establishing a buffer around the feature. As such, little impact would be incurred by the biota of the topographic features. The USEPA discharge regulations and permits would further reduce discharge-related impacts.

Blowouts could potentially cause damage to benthic biota; however, due to the application of the proposed Topographic Features Stipulation, blowouts would not reach the No Activity zone surrounding the topographic features and associated biota, resulting in little impact on the features. If a subsea oil plume is formed, it could contact the habitats of a topographic feature; this contact may be restricted to the lower, less sensitive levels of the banks and/or may be swept around the banks with the prevailing water currents. The farther the oil source is from the bank, the more dilute and degraded the oil would be when it reaches the vicinity of the topographic features.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The proposed Topographic Features Stipulation would keep sources of OCS spills at least 152 m (500 ft) away from the immediate biota of the topographic features. The majority of oil released below the sea surface rises and should not physically contact organisms on topographic features inside a No Activity Zone. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, it would be physically or chemically dispersed to low concentrations by the time it reached the feature, and the effects would be primarily sublethal. In the very unlikely event that oil from a subsurface spill reached an area containing hermatypic coral cover in lethal concentrations, the recovery could take in excess of 10 years (Fucik et al., 1984). Finally, in the unlikely event a freighter, tanker, or other oceangoing vessel related to OCS Program activities or non-OCS-related activities sank and proceeded to collide with the topographic features or associated habitat releasing its cargo, recovery could take years to decades, depending on the extent of the damage. Because these events are rare in occurrence, the potential of impacts from these events is considered low.

Non-OCS activities could mechanically disrupt the bottom (such as anchoring and treasure-hunting activities, as previously described). Natural events such as hurricanes or the collapse of the tops of the topographic features (through dissolution of the underlying salt structure) could cause severe impacts. The collapsing of topographic features is unlikely and would impact a single feature. Impacts from scuba diving, fishing, ocean dumping, and discharges or spills from tankering of imported oil could have detrimental effects on topographic features.

Overall, the incremental contribution of a CPA proposed action to the cumulative impact is negligible when compared with non-OCS impacts. Where the proposed Topographic Features Stipulation is applied, mechanical impacts (anchoring and structure emplacement) and impacts from operational discharges (produced waters, drilling fluids, cuttings) or accidental discharges (oil spills, blowouts) would be removed from the immediate area surrounding the topographic features. However, if the stipulation is not applied, acute long-term injury to topographic features may occur as a result of a CPA proposed action.

4.2.1.8. Sargassum Communities

4.2.1.8.1. Description of the Affected Environment

Sargassum is one of the most ecologically important brown algal genera found in the pelagic environment of tropical and subtropical regions of the world. The pelagic complex in the GOM is mainly comprised of *S. natans* and *S. fluitans* (Lee and Moser, 1998; Stoner, 1983; Littler and Littler, 2000). Both species of macrophytes (aquatic plants visible to the unaided eye) are hyponeustonic (living immediately below the surface) and fully adapted to a pelagic existence (Lee and Moser, 1998). Also known as gulf-weed or sea holly (Coston-Clements et al., 1991; Lee and Moser, 1998), *Sargassum* is characterized by a brushy, highly branched thallus (stem) with numerous leaf-like blades and berrylike pneumatocysts (air bladders or floats) (Coston-Clements et al., 1991; Lee and Moser, 1998; Littler and Littler, 2000). The air bladders contain mostly oxygen with some nitrogen and carbon dioxide, allowing for buoyancy. These floating plants may be up to a few meters in length and may be found floating alone or in larger rafts or mats that support communities of fish and a variety of other marine organisms. The distribution, size, and abundance of *Sargassum* mats varies depending on environmental and physiochemical factors such as temperature, salinity, and dissolved oxygen.

Habitat

Sargassum provides islands of high energy and carbon content in an otherwise nutrient and carbon poor environment (Stoner, 1983). Sargassum mats support a diverse assemblage of marine organisms including micro- and macro-epiphytes (plants that grow on other plants) (Carpenter and Cox, 1974; Coston-Clements et al., 1991), fungi (Winge, 1923), more than 100 species of invertebrates (Coston-Clements et al., 1991), over 100 species of fish (Dooley, 1972; Stoner, 1983), four species of sea turtles (Carr, 1987; Manzella et al., 2001), and various marine birds (Lee and Moser, 1998). *Sargassum* serves as nurseries, sanctuaries, and forage grounds for both commercially and recreationally exploited species. Numerous epipelagic fish (fish in upper ocean waters, where light penetrates) use the *Sargassum* as a source of food, certain flying fish lay eggs in the floating mats, and other fish use it as nursery grounds (Adams, 1960; Bortone et al., 1977; Dooley, 1972). Sea turtles have been seen using the protective mats for passive migration as hatchlings (Carr and Meylan, 1980). These communities may also vary depending on the environmental and physiochemical factors known to affect *Sargassum*, resulting in variable species composition, life histories, and diversity. It has been noted that inshore *Sargassum* communities differ in species composition than offshore communities, due to the varied effects of salinity and dissolved oxygen. Nearshore turbidity can also affect *Sargassum* community composition, as can nutrient-laden water. Recent findings suggest that *Sargassum* provides essential fish habitat that may have an influence on the recruitment success of several species (e.g., blue runner [*Caranx crysos*], gray triggerfish [*Balistes capriscus*], sargassumfish [*Histrio histrio*], greater amberjack [*Seriola dumerili*], and others) (South Atlantic Fishery Management Council, 2002; Wells and Rooker, 2004).

Invertebrates

Epiphytic cyanobacteria contribute to overall production and nutrient recycling within the *Sargassum* complex (Wells and Rooker, 2004). The algae is colonized first by bacteria, followed by hydroids and bryozoans, which provide the base of a food web containing a variety of invertebrates, fishes, and sea turtles (Bortone et al., 1977; Dooley, 1972).

Both sessile and motile invertebrates are found within the *Sargassum* community. Epifauna (animals living on the substrate) include colonial hydroids, encrusting bryozoans, the polychaete *Spirorbis*, barnacles, sea spiders, and the tunicate *Diplosoma*. Older plants can become heavily encrusted with these organisms, causing them to sink to the seafloor. A sunken mat will eventually disintegrate, providing further nourishment for animals in deeper water (Coston-Clements et al., 1991; Parr, 1939). Some of the motile fauna found within the floating communities includes polychaetes, flatworms, nudibranchs, decapod crustaceans (such as *Latreutes* and *Leander* shrimps and *Portunus* crabs), and various molluscs (including the *Sargassum* snail, *Litiopa melanostoma*) (Parr, 1939).

Fish

Fish assemblages in *Sargassum* mats located in the GOM and the Atlantic have shown similarities in species composition. In studies by Dooley (1972) and Bortone et al. (1977), 90-97 percent of the total catch was represented by jacks, pompanos, jack mackerels, scads, triggerfish, filefish, seahorse, pipefish, and frogfish in both regions. The abundance of juvenile fish associated with these mats suggests that they serve as an important nursery habitat for numerous species, including filefish, sergeant majors, tripletail, silver mullet, flying fish, and various jacks (Dooley, 1972). Some species that are endemic to *Sargassum* utilize the habitat for early life stages as well as adult stages, while other species may rely on the habitat only as a source of food and protection during early life stages (Wells and Rooker, 2004). The patterns of habitat use by many of the juvenile fish associated with *Sargassum* have exhibited spatial and temporal variability. Monthly influences such as environmental conditions appear to have an important role in the *Sargassum* fish assemblages within the northwestern GOM. By serving as an important nursery habitat for pelagic, benthic, and even estuarine species, *Sargassum* may have influence on the recruitment success of the fishes using it as habitat.

The importance of *Sargassum* differs among species depending on its role as essential fish habitat (EFH). The NMFS has designated *Sargassum* as EFH in the South Atlantic (Coston-Clements, 1991; USDOC, NMFS, 2010a). However, more studies are needed in order to evaluate the importance of *Sargassum* as habitat in the northwestern GOM, where *Sargassum* is the predominant cover and structure offering habitat for pelagic species at the sea surface.

Sea Turtles

Four of the five species of sea turtles found in the GOM are associated with floating *Sargassum* (Carr and Meylan, 1980; Carr, 1987; Coston-Clements et al., 1991; Schwartz, 1988). The hatchlings of loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*) sea turtles are thought to find the *Sargassum* rafts when actively seeking frontal zones, then utilizing the habitat as foraging grounds and protection during their pelagic "lost years" (juvenile years in which turtle sightings are scarce) (Carr, 1987; Coston-Clements et al., 1991). Schwartz (1988) reported numerous loggerhead hatchlings during commercial trawling for *Sargassum* in the Atlantic. This provided the largest count of hatchlings on record to date. After Hurricane David hit the Gulf in September 1979, Carr and Meylan (1980) collected dead and live turtles that were found in the *Sargassum* mats that had washed up on Cocoa Beach. The stomach content of the turtles was solely *Sargassum* floats and leafy parts, further emphasizing the importance of the habitat for pelagic growth stages of sea turtles.

Birds

A study by Lee and Moser (1998) found that the presence or absence of *Sargassum* drives local abundance and occurrence of certain species of marine birds. Various avian species utilize the resource in specific ways, by feeding on small fishes and other organisms in the *Sargassum* communities. In Lee and Moser's study, birds with over 25 percent of their prey living in *Sargassum* are classified as *Sargassum* specialists. Specialist species included shearwaters (59%), masked boobies (100%), phalaropes (62%), and various species of terns (40-60%). Both the GOM and Atlantic pelagic environment provide nutrient poor surface waters with low productivity. Therefore, the importance of this highly productive *Sargassum* community to seabird abundance and seasonal distribution is assumed to be high.

Distribution

Approximately 1 million wet cubic tons of *Sargassum* (*natans* and *fluitans*) is estimated to grow and circulate in the GOM annually. Over 80 percent of this is the dominant species *S. natans* (Parr, 1939). Wells and Rooker (2004) suggest that the abundance and age of *Sargassum* increases when found in slow-moving gyres, such as found in the western GOM and the Sargasso Sea (middle of the North Atlantic). These waters provide the ideal environment for *Sargassum* to grow and provide abundant habitat for associated organisms (Dooley, 1972).

Research by Gower and King (2008) suggests that the northwest GOM is the "major nursery area" for *Sargassum* that supplies the Atlantic population. The transportation of these plants is influenced by winds and ocean currents, and the winds over the Gulf blow predominantly from the east to the west and adjacent waters move from the west to the east (Parr, 1939; Rhodes et al., 1989). *Sargassum* originates in the northwestern GOM in March of each year, where it remains for long periods of time in the slowly rotating gyres of western GOM waters (Gower et al., 2006, Gower and King, 2008). In the months of May, June, and July, *Sargassum* is at its most abundant. The *Sargassum* begins to expand and spreads eastward into the central and eastern Gulf waters, taking up to 2 months to move across the Gulf, where it will eventually exit in the Loop Current. The movement of passive drift buoys deployed to track water currents corroborates this pattern of *Sargassum* movement from the Gulf to the Atlantic (Gower et al., 2006). It was previously assumed that *Sargassum* in the Atlantic originated in the Sargasso Sea. However, Gower and King (2008) used satellite imagery to determine that the Loop Current and Gulf Stream are responsible for distributing a large amount of *Sargassum* from the GOM into the Atlantic near Cape Hatteras in July and August. From September through February, the *Sargassum* that was distributed in the Atlantic mixes into the Sargasso Sea, loops around to the south, and dies in the waters north of the Bahamas, about a year after it originated in the GOM.

Historic Impacts on *Sargassum*

Studies by Parr (1939) and Stoner (1983) suggest that a significant decrease in *Sargassum* biomass has occurred from the 1930's through the 1980's, presumably because of increased pollutants and toxins in the pelagic environment. Burns and Teal (1973) found that *Sargassum* and its associates accumulate and concentrate petroleum hydrocarbons. *Sargassum* has been noted to have higher levels of toxins than in surrounding water samples in polluted areas. Note that there are scores of natural hydrocarbon seeps in the GOM that contribute hydrocarbons to oceanic waters. Oceanographic processes that concentrate *Sargassum* into mats and rafts may also concentrate toxic substances.

The DWH event released approximately 4.9 MMbbl of oil from the well over a period of 87 days. Of that volume, approximately 820,000 bbl were directly recovered via the riser insertion tube tool and the Top Hat. As a result, approximately 4.1 MMbbl were released into the environment. Much of the oil was treated with dispersant at the sea surface and at the source in 1,500-m (5,000-ft) water depth. The dispersed oil mixed with the water; its movement at the sea surface was dictated by wind, water currents, density, and the physical processes of degradation and dissolution. Hydrocarbon concentrations in the water column (Adcroft et al., 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010; OSAT, 2010) were close to, and below, the values reported by others for dispersed oil in the upper water column after oil spills. Field studies on dispersants have indicated that dispersed surface oil may be between 20 and 50 ppm at 1-5 m (3-16 ft) from the water's surface (McAuliffe et al., 1981a; Lewis and Aurand, 1997). McAuliffe et al. (1981a) reported dispersed oil concentrations between 1 and 3 ppm at 9 m (30 ft) below the sea surface at 1 hour after treatment with dispersant. Lewis and Aurand (1997) reported dispersed oil concentrations <1 ppm at 10 m (33 ft) below the sea surface.

Since *Sargassum* is a floating pelagic algae that is ubiquitous in the northern GOM, the portion of the population affected by DWH oil would be similar to the portion of the surface waters affected. While the GOM supports a sizeable population of *Sargassum*, it also serves as a nursery area for yearly growth that contributes to the population in the Atlantic. The highest concentration of *Sargassum* in the GOM during the months of June and July was in the vicinity of the DWH event in the CPA (Gower and King, 2008). Surface oil from the DWH event commonly coincided with lines and mats of *Sargassum*, and *Sargassum* mats were found immersed in oil with little or no visible living-associated organisms (Hernandez, 2011; Shipp, 2011; Haney, 2011; Witherington, official communication, 2011; USDOC, NMFS, 2010a; GMFMC, 2011). *Sargassum* populations in the CPA at the time would have been affected, while populations in the WPA were likely unaffected. Spill and cleanup efforts may have affected *Sargassum* in the spill area to some extent. Efforts to collect and burn oil on the sea surface would have taken *Sargassum* as well. Efforts to skim oil from the sea surface may have exacerbated the effect on *Sargassum* by sweeping the algae into oil and/or collecting it with oil.

The *Sargassum* community lives in pelagic waters with generally high water quality and is expected to show good resilience to the predicted effects of spills. It has a yearly cycle that promotes quick recovery from impacts. Impacts to *Sargassum* from the DWH event may have induced measurable changes in 2010. The algae population may be expected to recover in 1-2 seasons, but results are not available yet to make this determination.

A broad Internet search for relevant new information, as well as a search for scientific journal articles, was conducted using a publicly available search engine. A search for relevant information gathered during the *Ixtoc* spill of 1979 was conducted. In addition, the websites for Federal and State agencies, as well as other organizations, were reviewed for newly released information. Sources investigated include the South Atlantic Fishery Management Council, coordinated communications with the Gulf of Mexico Alliance, USEPA, USGS, and coastal universities. Interviews with personnel from academic institutions and governmental resource agencies were conducted to determine the availability of new information. In addition, there are ongoing NOAA- and National Science Foundation-funded research projects that are investigating the *Sargassum* distribution and impacts from the DWH event.

There remains incomplete or unavailable information on the effects of the DWH event on *Sargassum* that may be relevant to reasonably foreseeable significant adverse impacts. What scientifically credible information is available has been applied by BOEM subject-matter experts using accepted scientific methodologies. Samples and results developed as part of the NRDA process have not been released and there is no timeline for this information becoming available. Nevertheless, BOEM has determined that this incomplete or unavailable information is not essential to a reasoned choice among alternatives, because *Sargassum* are widely distributed throughout the Gulf and the yearly cycle of replenishment for *Sargassum* indicates that impacts from the DWH event would be significantly reduced or eliminated within a year or two.

4.2.1.8.2. Impacts of Routine Events

Impact-producing factors associated with routine events for a CPA proposed action that could affect *Sargassum* may include (1) drilling discharges (muds and cuttings); (2) produced water and well treatment chemicals; (3) operational discharges (deck drainage, sanitary and domestic water, bilge and ballast water); and (4) physical disturbance from vessel traffic and the presence of exploration and production structures (i.e., rigs, platforms, and MODU's).

Drilling activities differ from other routine activities in the use of drilling muds and the discharge of drill cuttings. Modern drilling muds are typically synthetic-based muds or water-based fluids. Synthetic muds are more costly than water-based muds and are routinely recycled rather than released. Water-based muds are relatively benign and are discharged in place. Oil-based drilling fluids are rarely used and when they are used, both the drilling muds and cuttings are removed to shore. The USEPA regulates the composition of drilling muds to limit toxic components permitted for use. Some muds are released during initial spudding of the well (the first segment of the well, before the outer casing is installed); however, this release of drilling muds is at the seafloor. Since the muds are heavier than seawater, the muds and cuttings from the spudding process generally settle to the seafloor within about 100 m (328 ft) of the well site (CSA, 2006). Therefore, this release at the seafloor would not affect the pelagic *Sargassum* community, which floats on and near the sea surface.

Drill cuttings are typically discharged from the drill platform (on or near the sea surface) during drilling. Drill cuttings are heavier than seawater and, when released at the sea surface in deep water, generally sink to the seafloor within less than 1,000 m (3,281 ft) of the well site (CSA, 2006). Cuttings can contain some concentrations of naturally-occurring substances that are toxic, e.g., arsenic, cadmium, mercury, other heavy metals, and hydrocarbons (Neff, 2005). Hydrogen sulfide is also produced from some wells. In addition, some amount of drilling muds is included with the cuttings discharges, as the recycling process is not 100 percent efficient. However, the composition of muds is strictly regulated and discharges of cuttings/muds are tested to ensure that toxicity levels are below the limits allowed by NPDES permits (USEPA, 2004, 2007c, and 2009c).

The routine discharge of drill cuttings and muds is expected to have little effect on *Sargassum* communities. There are three factors that support this conclusion. First, as highlighted above, muds and cuttings are heavier than seawater, so they would sink relatively rapidly. This means that the *Sargassum* at or near the sea surface would only be exposed to contact with discharges for a short time. The *Sargassum* would be traveling laterally with the surface water current; at the same time, the muds and cuttings would be rapidly sinking toward the seafloor. Second, the toxicity of muds and cuttings is limited by applicable regulations, so effects can be expected to be low if *Sargassum* is contacted. Third, discharges affect only a localized area of the sea surface. A CPA proposed action is estimated to result in a total of 383-746 wells in the CPA for the 40-year period (2012-2051) (**Table 3-3**). While this may seem like a large number of wells, they would affect only a very small portion of the 268,922 km^2 (103,831 mi^2) of the CPA. Although *Sargassum* occurs in most of the northern GOM, its distribution is patchy (Gower and King, 2011 and 2008; Gower et al., 2006; Wells and Rooker, 2004). Only a small percentage of *Sargassum* rafts would come in close proximity to drilling operations. Therefore, only a small portion of pelagic *Sargassum* in the GOM would come in contact with drill cuttings and muds and that contact would be brief.

Produced waters may have an effect on *Sargassum* communities. Water is often a component of the fluid extracted from a well in offshore oil and gas operations. It is more prevalent with oil than with gas extraction. The water is typically separated from the product on a platform and discharged at the sea surface. Produced waters usually have high salinity, high organic carbon, and low dissolved oxygen. Produced water may contain dissolved solids in higher concentrations than Gulf waters, metals, hydrocarbons, and naturally occurring radionuclides (Veil et al., 2004). Produced waters are rapidly diluted and impacts are generally only observed within close proximity of the discharge point (Gittings et al., 1992a). Possibly toxic concentrations of produced water were reported 20 m (66 ft) from the discharge in both the sediment and the water column where elevated levels of hydrocarbons, lead, and barium occurred, but no impacts to marine organisms or sediment contamination were reported beyond 100 m (328 ft) of the discharge (Neff and Sauer, 1991; Trefry et al., 1995). These characteristics could make the produced waters toxic to some organisms in the *Sargassum* community, particularly crustaceans and filter feeders (e.g., bryozoa). However, the produced waters are required to meet toxicity limits defined by NPDES permits and would further diffuse through the water mass, reducing concentrations of any toxic component (USEPA, 2004, 2007c, and 2009c). The *Sargassum* algae itself has a waxy coating and would be unlikely to be affected by possible short-term exposure.

Platform and service-vessel operational discharges may have an effect on water quality, indirectly affecting *Sargassum* in the immediate area of activity. Since the distribution of *Sargassum* is ubiquitous in the northern GOM, it would come in contact with operational discharges. However, considering the ratio of the affected area (immediately surrounding the activity) to the entire planning area, and even larger area inhabited by *Sargassum*, it is clear that only a small percentage of the total *Sargassum* population would contact operational discharges.

Vessel traffic and the presence of production structures may act as temporary barriers and obstacles for free-floating *Sargassum*. Stationary platforms and their associated fouling communities may snag pelagic *Sargassum* as it passes. In the event that *Sargassum* is caught in the propellers or cooling water intakes of vessels associated with a CPA proposed action, repairable damage may occur to the *Sargassum*.

Further research would enhance our knowledge of the effects, if any, of muds, cuttings, operational discharges, and physical impingement on *Sargassum* and its associated communities. *Sargassum* may have the capacity to absorb chemical substances, which may indirectly affect the health of the *Sargassum* and/or associated organisms. The likelihood that *Sargassum* would contact routine discharges or impinge on ships or stationary platforms is high. However, only a small part of the total population would receive these types of contact, contact would be only for a short time, and concentrations would be low (within permit limits). Given the ratio of *Sargassum* habitat to the surface area of the proposed activities, it is unlikely that a CPA proposed action would have any lasting effects on *Sargassum* and its associated community.

Summary and Conclusion

Sargassum, as pelagic algae, is a widely distributed resource that is ubiquitous throughout the GOM and northwest Atlantic. Considering its ubiquitous distribution and occurrence in the upper water column near the sea surface, it would contact routine discharges from oil and gas operations. All types of discharges including drill muds and cuttings, produced water, and operational discharges (e.g., deck runoff, bilge water, sanitary effluent, etc.) would contact *Sargassum* algae. However, the quantity and volume of these discharges is relatively small compared with the pelagic waters of the CPA (268,922 km^2 [103,831 mi^2]). Therefore, although discharges would contact *Sargassum*, they would only contact a very small portion of the *Sargassum* population. Because these discharges are highly regulated for toxicity and because they would continue to be diluted in the Gulf water, reducing concentrations of any toxic component, produced-water impacts on *Sargassum* would be minimal. Likewise, impingement effects by service vessels and working platforms and drillships would contact only a very small portion of the *Sargassum* population. The impacts to *Sargassum* that are associated with a CPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community as a whole. The *Sargassum* community lives in pelagic waters with generally high water quality and would be resilient to the minor effects predicted. It has a yearly cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community.

4.2.1.8.3. Impacts of Accidental Events

Proposed Action Analysis

Impact-producing factors associated with accidental events for a CPA proposed action that could affect *Sargassum* and its associated communities include (1) surface oil and fuel spills and underwater well blowouts, (2) spill-response activities, and (3) chemical spills. These impacting factors would have varied effects depending on the intensity of the spill and the presence of *Sargassum* in the area of the spill.

Oil spills are the major accidental events of concern to the *Sargassum* community. The risk of various sizes of oil spills occurring in the CPA as a result of a proposed action is presented in **Table 3-12**. The possibility of a spill ≥1,000 bbl resulting from a typical CPA lease sale is estimated to be up to one spill in the 40-year period (2012-2051) (**Appendix B**).

All known reserves in the GOM have specific gravity characteristics that indicate the oil would float to the sea surface. As discussed in **Chapter 3.2.1.5.4**, oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column, surfacing almost directly over the source location. Oil on the sea surface has the potential to negatively impact *Sargassum* communities. While components of oil on the sea surface would be removed through evaporation, dissipation, biodegradation, and oil-spill cleanup operations, much of it would persist until it contacts a shore. Oil at the sea surface can be mixed into the upper water column by wind and wave action to a depth of 10 m (33 ft) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Knap et al., 1985). With vigorous wave action, the oil can form an emulsion with water that is viscous and persistent. This emulsion floats on the sea surface and would be carried by wind and currents, likely coinciding with at least some of the *Sargassum* community.

When dispersants are applied to oil on the sea surface or at depth, its behavior is modified, causing the oil to mix with water. The dispersed oil would be suspended in the water column until it dissolves, flocculates with particulate matter until it becomes heavy enough to sink to the seafloor, or is biodegraded. Oil treated with dispersant at depth would form underwater plumes that would not rise to the sea surface. Oil treated with dispersant on the sea surface would mix with the water where its contact with *Sargassum* may be temporarily increased in the upper few meters of the water column. Data from other studies on dispersant usage on surface plumes indicate that a majority of the dispersed oil remained in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Field studies on dispersants have indicated that dispersed surface oil may be between 20 and 50 ppm at 1-5 m (3-16 ft) from the water's surface (McAuliffe et al., 1981a; Lewis and Aurand, 1997). McAuliffe et al. (1981a) reported dispersed oil concentrations between 1 and 3 ppm at 9 m (30 ft) below the sea surface at 1 hour after treatment with dispersant. Lewis and Aurand (1997) reported dispersed oil concentrations <1 ppm at 10 m (33 ft) below the sea surface. As time passes, the oil would begin to adhere to particles in the water column, form clumps, and sink toward the seafloor, and to biodegrade (ITOPF, 2002; Kingston, 1995).

The effects of oil contact with *Sargassum* communities would vary depending on the severity of exposure. *Sargassum* that contacts concentrated oil that coats the algae would likely succumb to the effects, die, and sink to the seafloor; attached organisms would suffer the same fate. Motile organisms that are dependent on the algae for habitat (shrimp, crabs, nudibranchs, snails, sargassum fish, etc.) may also be directly contacted by the oil or may be displaced into open water, resulting in death. *Sargassum* exposed to oil in lower concentrations may suffer sublethal effects. *Sargassum* that survives contact with a spill may exhibit levels of hydrocarbons, toxins, and chemicals that are concentrated up to four times that found in the adjacent uncontaminated waters (Burns and Teal, 1973). The effects of concentrated toxins on the macroalgae itself are undefined. It may result in the loss of associated organisms such as attached epifauna that use the algae as a substrate and other organisms that utilize the community as habitat including sea turtles, juvenile fish, and various invertebrates. Pelagic organisms feeding on the community may suffer sublethal effects that could reduce health and reproduction.

A catastrophic spill could affect a sizable portion of the *Sargassum* population. Since *Sargassum* is ubiquitous in the northern GOM, the portion of the population affected by surface oil would be similar to the portion of the surface waters affected. For example, if 10 percent of the surface waters of the northern GOM are affected by oil, about 10 percent of the *Sargassum* population at that time may come in contact with oil. However, a reliable estimate must also consider the annual cycle of *Sargassum* because density of the algae varies with season and across geographic locations. If the large spill occurs in an area of high or low *Sargassum* density, then a correspondingly higher or lower percent of the *Sargassum* population would be affected. Impacts from a catastrophic spill and cleanup effort could destroy a large enough portion of the population to affect subsequent populations in the Atlantic. The *Sargassum* community lives in pelagic waters with generally high water quality and is expected to show good resilience to the predicted effects of spills. It has a yearly cycle of natural die-off and regeneration from remnant populations that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community unless a catastrophic spill occurs.

Spill-response activities may contribute to negative impacts on *Sargassum*. The number of vessels working to clean a spill can increase physical damage to the *Sargassum* community, especially in the immediate vicinity of the spill. Vessels damage algae by cutting it with their propellers but impingement in cooling water intake is probably a larger effect. Vessels circulate seawater through shipboard systems as coolant. This can damage *Sargassum* directly; in addition, an antifoulant such as bleach or copper is typically injected to the water to prevent internal growth of organisms inside the systems. Other response activities, such as skimming oil from the sea surface, can also damage and remove *Sargassum*. However, these impacts may be inconsequential, as a large part of the *Sargassum* affected would already be contacted by oil. Another major response activity that may occur is the spraying of dispersant. Direct effects of dispersant on the *Sargassum* community are unknown but dispersants are known to be toxic to some invertebrates. The use of dispersants is a trade-off to achieve the least overall damage. For example, dispersants may increase short-term contact of oil with *Sargassum* and may have some inherent toxic properties but their use can prevent the formation of persistent emulsions and promote diffusion of oil resulting in biodegradation, clumping, and sinking.

Chemical spills are typically small (a few gallons to a few barrels of product) and are unlikely to produce any measurable impact on *Sargassum* communities. Due to the ubiquitous nature of *Sargassum* over most of the GOM, such spills are negligible to the overall population.

A spill may impact the productivity and longevity of *Sargassum* in an area. A very large spill may produce a measurable effect on the population of *Sargassum* in the Gulf of Mexico, reducing the overall biomass that is flushed into the Atlantic via the Loop Current and Gulf Stream. However, because of the nature of algal growth and the quality of the habitat under normal conditions, a more likely result is that local populations of *Sargassum* are affected that produce short-term measurable effects in the local area with rapid recovery. The *Sargassum* community is widely distributed over a very large area, including two oceans, and appears to have an annual cycle of growth that lends itself to resilient recovery in a short time.

Summary and Conclusion

Sargassum, as pelagic algae, is a widely distributed resource that is ubiquitous throughout the northern GOM and northwest Atlantic. Considering its ubiquitous distribution and occurrence in the upper water column near the sea surface, it would contact potential accidental spills from oil and gas operations. All types of spills including surface oil and fuel spills, underwater well blowouts, and chemical spills would contact *Sargassum* algae. The quantity and volume of most of these spills would be relatively small compared with the pelagic waters of the CPA (268,922 km^2 [103,831 mi^2]). Therefore, most spills would only contact a very small portion of the *Sargassum* population. The impacts to *Sargassum* that are associated with a CPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community unless a catastrophic spill occurs. In the case of a very large spill, the *Sargassum* algae community could suffer severe impacts to a sizable portion of the population in the northern GOM. The *Sargassum* community lives in pelagic waters with generally high water quality and is expected to show good resilience to the predicted effects of spills. It has a yearly growth cycle that promotes quick recovery from impacts and that would be expected restore typical population levels in 1-2 growing seasons.

4.2.1.8.4. Cumulative Impacts

Pelagic *Sargassum* algae is a common habitat found in the GOM and western Atlantic. It is comprised of floating mats of macroalgae that lives on the surface and upper water column of the sea, along with a varied community of organisms that inhabit it. It also supports a transient community of pelagic fish that take refuge and/or forage in the habitat. See **Chapter 4.2.1.8.1** for a description of *Sargassum* habitat. Several impacting factors can affect *Sargassum*, including impingement by structures and marine vessels, oil and gas drilling discharges, operational discharges, accidental spills, hurricanes, and coastal water quality.

Pelagic *Sargassum* floats at the surface in oceanic waters and is carried by surface currents across the GOM. Vessels transiting the Gulf pass through *Sargassum* mats, producing slight impacts to the *Sargassum* community by their passage, some propeller impacts, and possible impingement on cooling water intakes. None of these would have more than minor localized effects to the mats transited. Oil and gas structures can impede the movement of *Sargassum* mats and may entrap small quantities of the algae. This is expected to be a minor impact with no consequences to the overall *Sargassum* community.

Oil and gas drilling results in discharges of drill cuttings with small quantities of associated drilling muds and well treatment chemicals. Most cuttings from well drilling are discharged from the drill platform at the sea surface. This creates an area of high turbidity in the vicinity of drill operations. Small quantities of drill muds adhere to the cuttings that are discharged. Well treatment chemicals accompany muds into the well and may be discharged in small quantities with the cuttings. The composition of muds is strictly regulated and discharges of cuttings/muds are tested to ensure that toxicity levels are below the limits allowed by NPDES permits (USEPA, 2004, 2007c, and 2009c). Cuttings discharged at the sea surface may spread out to 1,000 m (3,280 ft) from the source, depending on currents, with the thickest layers at the well and the majority of the sediment within 250 m (820 ft) (CSA, 2006; Kennicutt et al., 1996). Fine components of the plume may travel farther but are dispersed in the water column and are distributed widely at low concentrations (CSA, 2004b; NRC, 1983). Contaminants from produced waters are reported in benthic environments up to 1,000 m (3,280 ft) from the source (Peterson et al., 1996; Armstrong et al., 1977; Osenberg et al., 1992). Floating mats of *Sargassum* that pass by a drilling operation would experience short-term exposure to drill cuttings with associated muds and well treatment chemicals. This may cause temporary stress to organisms including changes in respiration rate, abrasion, reduced feeding, reduced water filtration rates, and reduced response to physical stimulus (Anchor Environmental CA, L.P., 2003). These effects would be localized to a small portion of the total *Sargassum* population and represent a negligible amount of the incremental impact to *Sargassum* communities. Given the ratio of total *Sargassum* habitat to the surface area occupied by the proposed activities, it is unlikely that a CPA proposed action would have any lasting effects on *Sargassum* and its associated community.

Marine vessels of all types produce at least some minor effects to the environment. Oil and gas platforms and drill ships produce similar effects. Runoff water from the decks of ships and platforms may contain small quantities of oil, metals, and other contaminants. Larger vessels and offshore platforms discharge effluents from sanitary facilities (gray water). They also circulate seawater to cool ship's engines, electric generators, and other machines. The cooling water discharge may be up to 11°C (20°F) warmer than the surrounding sea water (USDHS, CG, and USDOT, MARAD, 2003; Patrick et al., 1993). This temperature difference can accumulate in the vicinity of the discharge. For ships this would only occur when the vessel is stationary, as in port. For oil and gas platforms and drill ships and for offshore Liquid Natural Gas terminals, localized warming of the water could occur (Emery et al., 1997; USDHS, CG, and USDOT, MARAD, 2003). However, the warm water is rapidly diluted, mixing to background temperature levels within 100 m (328 ft) of the source (USDHS, CG, and USDOT, MARAD, 2003). Effects from gray water, deck runoff, and cooling water are only notable for stationary locations. Produced waters from stationary locations are rapidly diluted and impacts are only observed within 100 m (328 ft) of the discharge point (Neff and Sauer, 1991; Trefry et al., 1995; Gittings et al., 1992a). Those effects are very localized, with only brief contact to passing *Sargassum* before dilution to background levels. These effects would comprise a negligible portion of the overall cumulative impact to *Sargassum* communities.

Accidental spills of oil and other chemicals could affect *Sargassum* and its community wherever they contact the algae. Small spills would have a limited local effect on a small portion of the *Sargassum* community. Short-term exposure of passing *Sargassum* to high concentrations of oil and chemicals could result in death and sinking of algae and organisms contacted. The size of the overall effect on *Sargassum* would depend on the size of the spill and the success of spill-response efforts. A catastrophic spill such as the DWH event could have noticeable impacts to the overall *Sargassum* community. These impacts could destroy a sizable portion of *Sargassum* habitat wherever the surface slick of oil travels. The effects could reduce the supply of algae transiting from the GOM to the Atlantic. This effect, although large, would contact only a portion of the algae in the region of the spill. *Sargassum* algae is a widespread habitat with patchy distribution across the northern GOM and the western Atlantic. Due to the vegetative production of *Sargassum* algae, the community would likely recover within 1-2 seasons (1-2 years). The probability of occurrence of a catastrophic spill is very low. If such a spill does occur, it would account for a sizable portion of the cumulative impact that affects *Sargassum*, although even such an impact would affect only a portion of the *Sargassum* in one region of its occurrence.

Hurricanes are major natural sources of impacts that affect the *Sargassum* community. The violent surface turbulence caused by these storms would dislocate many of the organisms living on and in the *Sargassum*. Some of the organisms (those that cannot swim or swim only weakly) such as nudibranchs (sea slugs), shrimp, sargassum fish (*Histrio histrio*), and pipefish (*Syngnathus* spp.) would become separated from the algae. Without cover, many would fall prey to larger fish after the storm; others may sink to the seafloor and die. Some epifauna, such as hydroids, living on the algae may suffer physical damage or be broken off. In addition, hurricanes drive large quantities of *Sargassum* toward shore, into coastal waters having less conducive conditions for *Sargassum* and even stranding large quantities on shore. Although hurricanes offer major physical damage to *Sargassum* communities, these are natural events for which the *Sargassum* is adapted. The general high quality of the pelagic habitat supports a thriving *Sargassum* algae community that can be expected to maintain high resilience, giving it a strong ability to recover from detrimental impacts. Although hurricanes cause widespread physical damage to the *Sargassum* community seasonally, the habitat routinely recovers from these stresses. Hurricane impacts may be a large part of the cumulative impacts to *Sargassum*, but they are a part of the normal cycle for the community.

Coastal water conditions are normally of lower quality than those found farther offshore in pelagic waters. *Sargassum* mats are often driven toward shore by onshore winds. Some is stranded on coastal barrier islands and beaches. Water quality conditions nearshore are different than the pelagic environment, with much higher turbidity, higher nutrients, and higher levels of contaminants. These conditions can be expected to cause stress to the algae and its inhabitants as they suffer from clogging of gills and filter mechanisms and lower light conditions. Increased coastal urbanization contributes to lower water quality in coastal waters, particularly near the outlets of rivers. This loss of *Sargassum* to shoreward movement is a normal part of community dynamics, although the effects may be exacerbated by increased declines in coastal water quality, caused in part by anthropogenic sources. As with hurricanes, loss of *Sargassum* to the coastal environment contributes to cumulative impacts for the overall community in the GOM.

A broad Internet search for relevant new information, as well as a search for scientific journal articles, was conducted using a publicly available search engine. In addition, the websites for Federal and State agencies, as well as other organizations were reviewed for newly released information. Sources investigated include the South Atlantic Fishery Management Council, coordinated communications with the Gulf of Mexico Alliance, USEPA, USGS, and coastal universities. Interviews with personnel from academic institutions and governmental resource agencies were conducted to determine the availability of new information. In addition, there are ongoing NOAA- and National Science Foundation-funded research projects that are investigating the *Sargassum* distribution and impacts from the DWH event. As noted in **Chapter 4.2.1.8.1**, even taking into account incomplete or unavailable information, impacts from the DWH event on *Sargassum* are expected to be significantly reduced or eliminated within the next few years. Due to the ubiquitous nature and widespread distribution of *Sargassum* in the Gulf and its annual cycle of growth, the overall population of *Sargassum* is expected to recover quickly.

Summary and Conclusion

Because of the ephemeral nature of Sargassum communities, many activities associated with a CPA proposed action would have a localized and short-term effect. Sargassum occurs seasonally in almost every part of the northern GOM, resulting in a wide distribution over a very large area. However, its occurrence is patchy, drifting in floating mats that are occasionally impinged on ships and on oil and gas structures. The large, scattered, patchy distribution results in only a small portion of the total population contacting ships, structures, or drilling discharges. There is also a low probability of a catastrophic spill to occur with a CPA proposed action. If such a spill did occur, Sargassum in that area is expected to suffer mortality. However, Sargassum resilience is good and recovery is expected within one or two growing seasons. The incremental contribution of a CPA proposed action to the overall cumulative impacts on Sargassum communities that would result from the OCS Program, environmental factors (such as hurricanes and coastal water quality), and non-OCS-related activities (such as non-OCS vessel traffic and commercial shipping) are expected to be minimal.

4.2.1.9. Chemosynthetic Deepwater Benthic Communities

The description of the environment of chemosynthetic communities and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action’s incremental contribution to the cumulative impacts are presented below. Chemosynthetic communities are susceptible to physical impacts from structure placement, anchoring, and pipeline installation associated with a CPA proposed action; however, the guidance provided in NTL 2009-G40 greatly reduces the risk of these physical impacts by requiring avoidance of seafloor areas with the potential to support sensitive deepwater benthic communities. In situations where substantial burial of the ubiquitous, soft-bottom benthic infaunal communities occurs, recolonization from populations of widespread neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms. Potential accidental events associated with a CPA proposed action are expected to cause little damage to the ecological function or biological productivity of widespread, ubiquitous, deep-sea, soft-bottom communities and widespread, low-density chemosynthetic communities. The most serious, cumulative, impact-producing factor threatening chemosynthetic communities is physical disturbance of the seafloor by OCS activities, which could destroy the organisms of these communities. The incremental contribution of a CPA proposed action to the cumulative impacts is expected to be slight, and adverse impacts would be limited but not completely eliminated by adherence to NTL 2009-G40.

4.2.1.9.1. Description of the Affected Environment

Continental Slope and Deepwater Resources

The northern GOM is a geologically complex basin. Its continental slope region has been described as the most complex in the world (Carney, 1997 and 1999; Rowe and Kennicutt, 2009). Regional topography of the slope consists of basins, knolls, ridges, and mounds derived from the dynamic adjustments of salt to the introduction of large volumes of sediment over long time scales. This region has become much better known in the last three decades, and the existing information is considerable, both from a geological and biological perspective. The first substantial collections of deep GOM benthos were made during the cruises of the USCG and Geodetic Steamer, *Blake*, between 1877 and 1880. Rowe and Menzel (1971) reported that their deep GOM infauna data were the first quantitative data published for this region. The first major study of the deep northern GOM was performed by a variety of researchers from Texas A&M University between 1964 and 1973 (Pequegnat, 1983). A total of 157 stations were sampled and photographed between depths of 300 and 3,800 m (984 and 12,467 ft) (the deepest part of the GOM). A more recent Agency-funded study was completed by LGL Ecological Research Associates and Texas A&M University in 1988, during which a total of 60 slope stations were sampled throughout the northern GOM in water depths between 300 and 3,000 m (9,842 ft) (Gallaway et al., 1988). As part of this multiyear study, along with trawls and quantitative box-core samples, 48,000 photographic images were collected and a large subset was quantitatively analyzed. Another major study, titled *Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study*, was completed in 2009. This 6-year project spanned three field sampling years and included collections of benthos and sediments through trawling, box coring, and bottom photography at a total of 51 stations ranging in depth from 213 to 3,732 m (699 to 12,244 ft), including some stations in Mexican waters (Rowe and Kennicutt, 2009).

“Deepwater” is a term of convenience referring (in this use) to vast areas of the Gulf with water depths ≥300 m (984 ft) that are typically covered by pelagic clay and silt. In, on, and directly above these sediments live a wide variety of single-celled organisms, invertebrates, and fish. Their lifestyles are extremely varied and can include absorption of dissolved organic material, symbiosis, collection of food through filtering, mucous webs, seizing, or other mechanisms including chemosynthesis. Chemosynthetic communities are a remarkable assemblage of invertebrates found in association with hydrocarbon seeps. The seeps provide a source of carbon independent of photosynthesis and the sun-dependent photosynthetic food chain that supports all other life on earth.

The continental slope is a transitional environment influenced by processes of both the shelf (<200 m; 650 ft) and the abyssal GOM (>975 m; 3,199 ft). This transitional character applies to both the pelagic and the benthic realms. The highest values of surface primary production are found in the upwelling areas in the De Soto Canyon region. In general, the eastern GOM is more productive in the oceanic region than is the western GOM. Nutrients in the system act as fertilizer, producing blooms in phytoplankton (single-celled algae). There is a time lag after each algae bloom as the zooplankton respond with a corresponding bloom as they feed on the phytoplankton. It is generally assumed that all the phytoplankton is consumed by zooplankton, except for brief periods during major plankton blooms. The zooplankton then egests a high percentage of their food intake as feces that sink toward the bottom and provide nutrients to benthic (seafloor) communities.

The proposed CPA lease sale area encompasses a vast range of habitats and water depths. The shallowest portions start nearshore at the boundary of State waters, and the deepest portions extend to approximately 3,500 m (11,483 ft) south of the Sigsbee Escarpment in the central Gulf, nearly into the deepest part of the Gulf of Mexico. This is not particularly deep for the rest of the world’s oceans, but it is within a few hundred meters of the deepest point of the GOM (3,800 m; 12,467 ft), which is only accessible from Mexican waters of the southern Gulf. The proposed lease sale area also includes the lower portions of De Soto Canyon, the most notable sea-bottom feature on the upper slope in this area. Its formation has been attributed to a combination of erosion, deposition, and structural control of salt diapirs clustered in the vicinity (Harbison, 1968). Although the northeastern edge of the canyon has a steep slope, unlike most submarine canyons, De Soto Canyon has a comparatively gentle gradient; it exerts a dominant control over water current structure, upwelling features, and increases in biological productivity due to upwelling. Mississippi Canyon is another prominent deepwater feature. The sediment-laden freshwater plume from the Mississippi River itself and the Gulf Loop Current are the major controlling oceanographic factors in the CPA (and beyond).

A great number of publications have been derived from the two major Agency-funded deep Gulf studies of Gallaway et al. (1988) and Rowe and Kennicutt (2009). These two studies provide extensive background information on deepwater GOM habitat and biological communities.

Deepwater fauna can be grouped into major assemblages defined by depth, including (1) upper slope, (2) mid-slope, (3) lower slope, and (4) abyssal plain (Rowe and Kennicutt, 2009). (The seven zones previously described by Pequegnat [1983] and confirmed by LGL Ecological Research Associates, Inc. and Texas A&M University [Gallaway et al., 1988] now appear to be too numerous.) Carney et al. (1983) postulated a simpler system of zonation having three zones: (1) a distinct shelf fauna in the upper 1,000 m (3,281 ft); (2) indistinct slope fauna between 1,000 and 2,000 m (3,281 and 6,562 ft); and (3) a distinct abyssal fauna between 2,000 and 3,000 m (6,562 and 9,843 ft). The 450-m (1,476-ft) isobath defines the truly deep-sea fauna where the aphotic zone begins. In these sunlight-deprived waters, photosynthesis cannot occur and processes of food consumption, biological decomposition, and nutrient regeneration occur in cold and dark waters. The lowermost layer is the benthic zone, including the bottom itself and the waters immediately above it. This zone is a repository of sediments where nutrient storage and regeneration take place in association with the solid and semisolid substrate (Pequegnat, 1983). The continental slope and the abyssal zone (≥1,000 m; 3,281 ft) have the following divisions and characteristic faunal assemblages:

- Shelf-Slope Transition Zone (150-450 m; 492-1,476 ft)—A very productive part of the benthic environment. Demersal fish are dominant, many reaching their maximum populations in this zone. Asteroids, gastropods, and polychaetes are common.
- Archibenthal Zone – Horizon A (475-740 m; 1,558-2,428 ft)—The Horizon A Assemblage is located between 475 and 740 m. Although less abundant, the demersal fish are a major constituent of the fauna, as are gastropods and polychaetes. Sea cucumbers are more numerous.
- Archibenthal Zone – Horizon B (775-950 m; 2,543-3,117 ft)—The Horizon B Assemblage, located at 775-950 m, represents a major change in the number of species of demersal fish, asteroids, and echinoids, which reach maximum populations here. Gastropods and polychaetes are still numerous.
- Upper Abyssal Zone (1,000-2,000 m; 3,281-6,562 ft)—Number of fish species decline while the number of invertebrate species appear to increase; sea cucumbers, *Mesothuria lactea* and *Benthodytes sanguinolenta*, are common; galatheid crabs include 12 species of the deep-sea genera *Munida* and *Munidopsis*, while the shallow brachyuran crabs decline.
- Mesoabyssal Zone (2,300-3,000 m; 7,546-9,843 ft)—Fish species are few, and echinoderms continue to dominate the megafauna.
- Lower Abyssal Zone (3,200-3,800 m; 10,499 to 12,468 ft)—Large asteroid, *Dynaster insignis*, is the most common megafaunal species.

The vast majority of the Gulf of Mexico seabed is comprised of soft sediments. Major groups of animals that live in this habitat include (1) megafauna (larger organisms such as crabs, sea pens, sea cucumbers, crinoids, and demersal [bottom-dwelling] fish); (2) macrofauna (>0.3 mm); (3) meiofauna (0.063-0.3 mm); and (4) bacteria and other microbenthos. All of these groups are represented throughout the entire Gulf − from the continental shelf to the deepest abyssal depths.

Megafauna: Animals of a size typically caught in trawls and large enough to be easily visible (e.g., crabs, shrimp, benthic fish, etc.) are called megafauna. In the Gulf, most are crustaceans, echinoderms, or benthic fish. Benthic megafaunal communities in the deep Gulf appear to be typical of most temperate continental slope assemblages found at depths from 300 to 3,000 m (984 to 9,843 ft) (USDOI, MMS, 2001, p. 3-63). Exceptions include the chemosynthetic communities. Although soft-bottom fauna are expected to predominate, occasional sea pens, sea whips, and sponges are observed during ROV surveys (Geoscience Earth & Marine Services, Inc., 2005).

Megafaunal invertebrate and benthic fish densities appear to decline with depth between the upper slope and the abyssal plain (Pequegnat 1983; Pequegnat et al., 1990). This phenomenon is generally believed to be related to the low productivity in deep, offshore Gulf waters (USDOI, MMS, 2001, p. 3-60). Megafaunal communities in the offshore Gulf have historically been zoned by depth (see above), which are typified by certain species assemblages (Menzies et al., 1973; Pequegnat, 1983; Carney et al., 1983; Gallaway et al., 1988; Gallaway and Kennicutt, 1988; Pequegnat et al., 1990; USDOI, MMS, 2001, p. 3-64; Rowe and Kennicutt, 2009).

The baseline Northern Gulf of Mexico Continental Slope (NGMCS) Study conducted in the mid- to late 1980’s trawled 5,751 individual fish and 33,695 invertebrates, representing 153 and 538 taxa, respectively. That study also collected 56,052 photographic observations, which included 76 fish taxa and 193 non-fish taxa. The photographic observations were dominated by sea cucumbers, bivalves, and sea pens, groups that were not sampled effectively (if at all) by trawling. Decapod crustaceans dominated the trawls and were fourth in abundance in photos. Decapod density generally decreased with depth but abundance peaks were determined at 500 m (1,640 ft) and between 1,100 and 1,200 m (3,609 and 3,937 ft), beyond which numbers diminished. Fish density, while variable, was generally high at depths between 300 and 1,200 m (984 and 3,937 ft); it then declined substantially.

Gallaway et al. (2003) concluded that megafaunal composition changes continually with depth such that a distinct upper slope fauna penetrates to depths of about 1,200 m (3,937 ft) and a distinct deep-slope fauna is present below 2,500 m (8,202 ft). A broad transition zone characterized by low abundance and diversity occurs between depths of 1,200 and 2,500 m (3,937 and 8,203 ft).

Macrofauna: The benthic macrofaunal component (>0.3 mm) of the NGMCS Study (Gallaway et al., 2003) included sampling in nearby areas at similar depths, both east and west of a proposed action. The NGMCS Study examined 69,933 individual macrofauna from over 1,548 taxa; 1,107 species from 46 major groups were identified (Gallaway et al., 2003). Polychaetes (407 species), mostly deposit-feeding forms (196 taxa), dominated in terms of numbers. Carnivorous polychaetes were more diverse, but less numerous than deposit-feeders, omnivores, or scavengers (Pequegnat et al., 1990; Gallaway et al., 2003). Polychaetes were followed in abundance by nematodes, ostracods, harpacticoid copepods, bivalves, tanaidacids, bryozoans, isopods, amphipods, and others. Overall abundance of macrofauna ranged from 518 to 5,369 individuals/m^2 (Gallaway et al., 1988). The central transect (4,938 individuals/m^2) had higher macrofaunal abundance than either the eastern or western Gulf transects (4,869 and 3,389 individuals/m^2, respectively) (Gallaway et al., 2003).

In the GOM, macrofaunal density and biomass decline with depth from approximately 5,000 individuals/m^2 on the lower shelf-upper slope to several hundred individuals/m^2 on the abyssal plain (USDOI, MMS, 2001, p. 3-64). This decline in benthos has been attributed to the relatively low productivity of the Gulf offshore open waters (USDOI, MMS, 2001, p. 3-60). Pequegnat et al. (1990) reported mid-depth maxima of macrofauna in the upper slope at some locations with high organic particulate matter, and Gallaway et al. (2003) noted that the decline with depth is not clear cut and is somewhat obscured by sampling artifacts. There is some suggestion that the size of individuals decrease with depth (Gallaway et al., 2003).

Meiofauna: Meiofauna (0.063-0.3 mm) primarily composed of small nematode worms also decline in abundance with depth (as with megafauna and macrofauna) (Pequegnat et al., 1990; USDOI, MMS, 2001, p. 3-64; Gallaway et al., 2003). The overall density (mean of 707,000/m^2) of meiofauna is approximately two orders of magnitude greater than the macrofauna throughout the depth range of the slope (Gallaway et al., 1988). These authors reported 43 major groups of meiofauna with nematodes, harpacticoid copepods (adults and larvae), polychaete worms, ostracods, and kinorhynchs accounting for 98 percent of the total numbers. Nematode worms and harpacticoids were dominant in terms of numbers, but polychaetes and ostracods were dominant in terms of biomass, a feature that was remarkably consistent across all stations, regions, seasons, and years (Gallaway et al., 2003). Meiofaunal densities appeared to be somewhat higher in the spring than in the fall. Meiofaunal densities reported in the NGMCS Study are among the highest recorded worldwide (Gallaway et al., 2003). There is also evidence that the presence of chemosynthetic communities may enrich the density and diversity of meiofauna in their immediate surrounding areas (Gallaway et al., 2003).

Microbiota: Less is known about the microbiota (<0.063 mm) in the GOM than the other size groups, especially in deep water (CSA, 2000; USDOI, MMS, 2000a, p. IV-15). While direct counts have been coupled with some in situ and repressurized metabolic studies performed in other deep ocean sediments (Deming and Baross, 1993), none have been made in the deep GOM. Cruz-Kaegi (1998) made direct counts using a fluorescing nuclear stain at several depths down the slope, allowing bacterial biomass to be estimated from their densities and sizes. Mean biomass was estimated to be 2.37 g of carbon/m^2 for the shelf and slope combined, and 0.37 g of carbon/m^2 for the abyssal plain. In terms of biomass, data indicate that bacteria are the most important component of the functional infaunal biota. Cruz-Kaegi (1998) developed a carbon cycling budget based on estimates of biomass and metabolic rates in the literature. She discovered that, on the deep slope of the Gulf, the energy from organic carbon in the benthos is cycled through bacteria.

Chemosynthetic Communities

Chemosynthetic communities are remarkable in that they utilize a carbon source independent of photosynthesis and the sun-dependent photosynthetic food chain that supports all other life on earth. Although the process of chemosynthesis is entirely microbial, chemosynthetic bacteria can support thriving assemblages of higher organisms. This is accomplished through symbiotic relationships in which the chemosynthetic bacteria live within the tissues of tube worms and bivalves and provide a food source for their hosts. The first discovery of deep-sea chemosynthetic communities including higher animals was unexpectedly made at hydrothermal vents in the eastern Pacific Ocean during geological explorations (Corliss et al., 1979). The principal organisms included tube worms, clams, and mussels that derive their entire food supply from symbiotic chemosynthetic bacteria, which obtain their energy needs from chemical compounds in the venting fluids. Similar communities were first discovered in the eastern Gulf of Mexico in 1983 at the bottom of the Florida Escarpment in areas of “cold” brine seepage (Paull et al., 1984). The fauna here was found to be generally similar to vent communities, including tube worms, mussels, and rarely, vesicomyid clams.

Two groups fortuitously discovered chemosynthetic communities in the Gulf of Mexico concurrently in November 1984. During investigations by Texas A&M University to determine the effects of oil seepage on benthic ecology (until this investigation, all effects of oil seepage were assumed to be detrimental), bottom trawls unexpectedly recovered extensive collections of chemosynthetic organisms including tube worms and clams (Kennicutt et al., 1985). At the same time, LGL Ecological Research Associates was conducting a research cruise as part of the Agency-funded, multiyear Northern Gulf of Mexico Continental Slope Study (LGL Ecological Research Associates, Inc. and Texas A&M University, 1986). Bottom photography resulted in clear images of vesicomyid clam chemosynthetic communities. Photography during the same LGL cruise also documented tube-worm communities in situ in the Gulf of Mexico for the first time (Boland, 1986) prior to the initial submersible investigations and firsthand descriptions of Bush Hill in 1986 (Rosman et al., 1987a; MacDonald et al., 1989).

Distribution

There is a clear relationship between known hydrocarbon discoveries at great depth in the Gulf slope and chemosynthetic communities, hydrocarbon seepage, and authigenic minerals, including carbonates at the seafloor (Sassen et al., 1993a and 1993b). While the hydrocarbon reservoirs are broad areas several kilometers beneath the Gulf, chemosynthetic communities occur in isolated areas with thin veneers of sediment only a few meters thick.

The northern Gulf of Mexico slope includes a stratigraphic section more than 10 km (6 mi) thick that has been profoundly influenced by salt movement. Mesozoic source rocks from Upper Jurassic to Upper Cretaceous generate oil in most of the Gulf slope fields (Sassen et al., 1993a and 1993b). Migration conduits supply fresh hydrocarbon materials through a vertical scale of 6-8 km (4-5 mi) toward the surface. The surface expressions of hydrocarbon migration are referred to as seeps. Geological evidence demonstrates that hydrocarbon and brine seepage persists in spatially discrete areas for thousands of years. The time scale for oil and gas migration (combination of buoyancy and pressure) from source systems is on the scale of millions of years (Sassen, 1998). Seepage from hydrocarbon sources through faults towards the surface tends to be diffused through the overlying sediment, carbonate outcroppings, and hydrate deposits so the corresponding hydrocarbon seep communities tend to be larger (a few hundred meters wide) than chemosynthetic communities found around the hydrothermal vents of the Eastern Pacific (MacDonald, 1992). There are large differences in the concentrations of hydrocarbons at seep sites.

The widespread nature of Gulf of Mexico chemosynthetic communities was first documented during contracted investigations by the Geological and Environmental Research Group (GERG) of Texas A&M University for the Offshore Operators Committee (Brooks et al., 1986). The occurrence of chemosynthetic organisms dependent on hydrocarbon seepage has been documented in water depths as shallow as 290 m (951 ft) (Roberts et al., 1990) and as deep as 2,200 m (7,218 ft) (MacDonald, 1992). This depth range specifically places chemosynthetic communities in the deepwater region of the Gulf of Mexico, which is defined as water depths greater than 300 m (984 ft). Chemosynthetic communities are not found on the continental shelf. At least 69 communities are now known to exist in the Gulf (**Figure 4-8**). Although a systematic survey has not been done to identify all chemosynthetic communities in the Gulf, there is evidence indicating that many more such communities may exist. The depth limits of discoveries probably reflect the limits of exploration (lack of submersibles capable of depths over 1,000 m [3,281 ft]). MacDonald et al. (1993 and 1996) have analyzed remote-sensing images from space that reveal the presence of oil slicks across the north-central Gulf of Mexico. Results confirmed extensive natural oil seepage in the Gulf, especially in water depths greater than 1,000 m (3,281 ft). A total of 58 additional potential locations were documented where seafloor sources were capable of producing perennial oil slicks (MacDonald et al., 1996). Estimated seepage rates ranged from 4 to 70 bbl/day compared with less than 0.1 bbl/day for ship discharges (both normalized for 1,000 mi^2 [3,430 km^2]). This evidence considerably increases the area where chemosynthetic communities dependent on hydrocarbon seepage may be expected.

Additional research recently released by BOEM further reinforces the idea that there are many more potential deepwater live-bottom sites than previously expected. Analyses of seafloor seismic data by BOEM geophysicists have revealed over 21,000 seafloor seismic amplitude anomalies. These are areas of anomalously high or low seafloor reflectivity. They represent three categories of seafloor features: (1) high positive amplitudes indicative of carbonate hard bottoms produced by chemosynthetic bacterial activity; (2) low positive to negative anomalies due to high flux of hydrocarbons, usually producing mud volcanoes or flows of mud downslope and possible chemosynthetic activity; and (3) pockmarks that likely result from explosive release of gases from the seafloor. The third category is not associated with chemosynthetic activity, but the first two are expected to represent possible chemosynthetic and deepwater coral communities. The high positive anomalies show high reflectance due to the presence of hard-bottom areas. These hard bottoms are created by the precipitation of calcium carbonate substrate through chemosynthetic bacterial activity. These high reflectance areas are likely to support chemosynthetic communities along with possible deepwater coral communities. The low positive anomalies represent areas with a high flux of hydrocarbons. Such areas often have too much flow to be conducive to development of chemosynthetic communities. However, chemosynthetic bacteria and clams may colonize portions of the area. **Figure 4-9** shows polygons for the locations of high and low positive/negative anomalies representing possible chemosynthetic and deep coral communities (USDOI, BOEMRE, 2011c).

The densest aggregations of chemosynthetic organisms have been found at water depths of around 500 m (1,640 ft) and deeper. The best known of these communities was named Bush Hill by the investigators who first described it (MacDonald et al., 1989). It is a surprisingly large and dense community of chemosynthetic tube worms and mussels at a site of natural petroleum and gas seepage over a salt diapir in Green Canyon Block 185. The seep site is a small knoll that rises about 40 m (131 ft) above the surrounding seafloor in water about 580 m (1,903 ft) deep.

Stability

According to Sassen (1998), the role of naturally occurring methane hydrates at chemosynthetic communities had been greatly underestimated. Gas hydrates are a unique and poorly understood class of chemical substances in which molecules of one material (in this case water in solid state—ice) form an open lattice that physically encloses molecules of a certain size (in this case ─ methane) in a cage-like structure without chemical bonding. The biological alteration of frozen gas hydrates was first discovered during the Agency-funded study *Stability and Change in Gulf of Mexico Chemosynthetic Communities* (Sager, 1997). It is hypothesized that the dynamics of hydrate alteration could play a major role as a mechanism for the regulation of the release of hydrocarbon gases to fuel biogeochemical processes and could also play a substantial role in community stability (MacDonald, 1998). Recorded bottom-water temperature excursions of several degrees in some areas such as the Bush Hill site (4-5 °C [39-41 °F] at 500-m [1,640-ft] depth) are believed to result in dissociation of hydrates, resulting in an increase in gas fluxes (MacDonald et al., 1994). Although not as destructive as the volcanism at vent sites of the mid-ocean ridges, the dynamics of shallow hydrate formation and movement will clearly affect sessile animals that form part of the seepage barrier. There is the potential for an entire layer of shallow hydrate to break free of the bottom and result in considerable impact to local communities of chemosynthetic fauna. At deeper depths (>1,000 m; >3,281 ft), the bottom-water temperature is colder (by approximately 3 °C [37 °F]) and undergoes less fluctuation. The formation of more stable and probably deeper hydrates influences the flux of light hydrocarbon gases to the surface, thus influencing the surface morphology and characteristics of chemosynthetic communities.

Powell (1995) reported on the notable uniqueness of each chemosynthetic community site. Through taphonomic studies (death assemblages of shells) and interpretation of seep assemblage composition from cores, Powell (1995) reported that, overall, seep communities were persistent over periods of 500-1,000 years. Some sites retained optimal habitat over geological time scales. Powell reported evidence of mussel and clam communities persisting in the same sites for 500-4,000 years. Powell also found that both the composition of species and trophic tiering of hydrocarbon seep communities tend to be fairly constant across time, with temporal variations only in numerical abundance. He found few cases in which the community type changed (from mussel to clam communities, for example) or had disappeared completely. Faunal succession was not observed. Surprisingly, when recovery occurred after a past destructive event, the same chemosynthetic species reoccupied a site. There was little evidence of catastrophic burial events, but two such instances were found in mussel communities in Green Canyon Block 234.

Precipitation of authigenic carbonates and other geologic events will undoubtedly alter surface seepage patterns over periods of 1-2 years; although through direct observation, no changes in chemosynthetic fauna distribution or composition were observed at seven separate study sites (MacDonald et al., 1995). A slightly longer period (12 years) can be referenced in the case of Bush Hill, the first community described in situ in 1986. No mass die-offs or large-scale shifts in faunal composition have been observed over the 12-year history of research at this site.

Biology

MacDonald et al. (1990) has described four general community types. These are communities dominated by Vestimentiferan tube worms (*Lamellibrachia c.f. brahma* and *Escarped* sp.), mytilid mussels (Seep Mytilid IA, I, and III, and others), vesicomyid clams (*Vesicomya cordata* and *Calyptogena ponderosa*), and infaunal lucinid or thyasirid clams (*Lucinoma* sp. or *Thyasira* sp.). These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them. Many of the species found at these cold seep communities in the Gulf are new to science and remain undescribed. As an example, at least six different species of seep mussels have been collected, but none is yet described.

Individual lamellibrachid tube worms, the longer of two taxa found at seeps (the other is an *Escarpia*-like species but probably a new genus), can reach lengths of 3 m (10 ft) and live hundreds of years (Fisher et al., 1997). Growth rates determined from recovered marked tube worms have been variable, ranging from no growth of 13 individuals measured one year to a maximum growth of 20 mm/yr (0.8 in/yr) in a *Lamellibrachia* individual. Average growth rate was 2.5 mm/yr (0.1 in/yr) for the *Escarpia*-like species and 7.1 mm/yr (0.28 in/yr) for lamellibrachids. These are slower growth rates than those of their hydrothermal vent relatives, but *Lamellibrachia* individuals can reach lengths 2-3 times that of the largest known hydrothermal vent species. Lamellibrachid tube worms over 3 m (10 ft) long have been collected on several occasions. Tube worms of this length are probably over 400 years old (Fisher, 1995). Vestimentiferan tube worm spawning is not seasonal and recruitment is episodic.

Growth rates for methanotrophic mussels at cold seep sites have been reported (Fisher, 1995). General growth rates were found to be relatively high. Adult mussel growth rates were similar to mussels from a littoral environment at similar temperatures. Fisher also found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults; they grow to reproductive size very quickly. Both individuals and communities appear to be very long lived. These methane-dependent mussels have strict chemical requirements that tie them to areas of the most active seepage in the Gulf of Mexico. As a result of their rapid growth rates, mussel recolonization of a disturbed seep site could occur relatively rapidly. There is some early evidence that mussels also have some requirement of a hard substrate and could increase in numbers if suitable substrate is increased on the seafloor (Fisher, 1995).

Unlike mussel beds, chemosynthetic clam beds may persist as a visual surface phenomenon for an extended period without input of new living individuals because of low dissolution rates and low sedimentation rates. Most clam beds investigated by Powell (1995) were inactive, with little sign of growth. Living individuals were rarely encountered. Powell reported that, over a 50-year time span, local extinctions and recolonization should be gradual and exceedingly rare.

Extensive mats of free-living bacteria are also evident at hydrocarbon seep sites. These bacteria may compete with the major fauna for sulfide and methane energy sources and may also contribute substantially to overall production (MacDonald, 1998). The white, nonpigmented mats were found to be an autotrophic sulfur bacteria *Beggiatoa* species, and the orange mats possessed an unidentified nonchemosynthetic metabolism (MacDonald, 1998).

Preliminary information has been presented by Carney (1993) concerning the nonchemosynthetic animals (heterotrophs) found in the vicinity of hydrocarbon seeps. Heterotrophic species at seep sites are a mixture of species unique to seeps (particularly molluscs and crustacean invertebrates) and those that are a normal component from the surrounding environment. Carney reports a potential imbalance that could occur as a result of chronic disruption. Because of sporadic recruitment patterns, predators could gain an advantage, resulting in exterminations in local populations of mussel beds.

Detection

Chemosynthetic communities cannot be reliably detected directly using geophysical techniques; however, hydrocarbon seeps and chemosynthetic communities living on them modify the near-surface geological characteristics in ways that can be remotely detected. These known sediment modifications include the following: (1) precipitation of authigenic carbonate in the form of micronodules, nodules, or rock masses; (2) formation of gas hydrates; (3) modification of sediment composition through concentration of hard chemosynthetic organism remains (such as shell fragments and layers); (4) formation of interstitial gas bubbles or hydrocarbons; and (5) formation of depressions or pockmarks by gas expulsion. These features give rise to acoustic effects such as wipeout zones (no echoes), hard bottoms (strongly reflective echoes), bright spots (reflection enhanced layers), or reverberant layers (Behrens, 1988; Roberts and Neurauter, 1990). Potential locations for most types of communities can be determined by careful interpretation of these various geophysical modifications, but to date, the process remains imperfect and confirmation of living communities requires direct visual techniques.

As part of the Agency-funded study, *Stability and Change in Gulf of Mexico Chemosynthetic Communities*, Sager (1997) characterized the geophysical responses of seep areas that support chemosynthetic communities so that a protocol has been refined to use geophysical remote-sensing techniques to locate chemosynthetic communities reliably. One objective is to use geophysical mapping techniques to reduce the seafloor area that may require searching by much slower and expensive near-bottom techniques.

Effects of the Deepwater Horizon *Event on the Baseline of Chemosynthetic Communities*

The DWH event released an estimated 4.9 MMbbl of oil from the well over an 87-day period following the event. Extensive literature, Internet, and database searches have been conducted for results of scientific data. Although many research cruises have occurred, very few scientific analyses have been published as of this writing. Descriptions of studies completed or in progress are discussed, and available results are included. Although the impacts of the oil spill are not yet known, possible impacts to deepwater benthic communities are discussed.

Several opposing forces dictated the behavior of the oil from the DWH event. The oil was lighter than water and a portion of it was buoyed to the sea surface. However, it was injected into deep water under high pressure, which resulted in vigorous turbulence and the formation of micro-droplets that were not buoyant enough to float to the surface. The upward movement of the oil was also reduced because methane in the oil was dissolved at high underwater pressures, reducing the oil's buoyancy (Adcroft et al., 2010). The Joint Analysis Group (2010a) reported that oil droplets less than 100 μm in diameter were likely to remain in the water column for several months. Much of the oil was treated with dispersant at the sea surface and at the source in 1,500 m (5,000 ft) of water depth. It is reported that chemically dispersed surface oil from the DWH event remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded (Lubchenco et al., 2010). Data from other studies of dispersant usage on surface plumes indicate that a majority of the dispersed oil remained in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Any dispersed oil that reached the seafloor from the water's surface during this event would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to adhere to particles in the water column, delaying flocculation and sinking to the seafloor (McAuliffe et al., 1981a). Oil exposed to dispersant chemicals became more dispersed and less concentrated the longer it remained floating or suspended in the water column. These oil droplets remained neutrally buoyant in the water column, creating a subsurface plume of oil (Adcroft et al., 2010). Concentrations of dispersed and dissolved oil in the subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010). Depending on how long it remained in the water column, oil may have been thoroughly degraded by biological action before contact with the seafloor. Water currents could have carried a plume to contact the seafloor directly but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston, 1995; ITOPF, 2002). Oil also would have reached the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Distribution of the dispersed oil was dictated by water currents, density, and the physical processes of dispersion and degradation. These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010).

Lubchenco et al. (2010) and the Federal Interagency Solutions Group (2010) estimated that up to 52 percent of the total spill volume remained at large in the GOM shortly after the Macondo well was capped on July 15, 2010 (in various forms: 16% chemically dispersed, 13% naturally dispersed, and 23% other).

The majority of the seafloor of the Gulf of Mexico is covered in soft sediments. Oil released from the DWH event may have affected some of the organisms that live on or in these sediments. Direct contact with high concentrations of oil may have resulted in acute toxicity to organisms. Exposures to lower concentrations may have resulted in sublethal impacts such as altered reproduction, growth, respiration, excretion, chemoreception, feeding, movement, stimulus response, and susceptibility to disease (Suchanek, 1993). It is important to note that the effects of oil exposure on soft-bottom benthos are anticipated to have only impacted a relatively small portion of the seafloor of the Gulf of Mexico. The greatest concentrations are expected to be near the wellhead and to decrease with distance from the source. In situations where soft-bottom infaunal communities were negatively impacted, recolonization by populations from neighboring soft-bottom substrate would be expected for all size ranges of organisms in less than 1 year (Lu and Wu, 2006; Netto et al., 2009; Santos et al., 2009). This could take longer for areas affected by direct oil contact in higher concentrations.

A recent report documents damage to a deepwater coral community in the CPA in an area that oil plume models predict as the direction of travel for subsea oil plumes from the DWH event. Results are still pending but it appears that a coral community about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged, possibly the result of oil impacts (USDOI, BOEMRE, 2010j). A major difference between this occurrence and likely effects on soft bottoms is that the coral community forms structures that protrude up into the water column. These upright corals would be affected by a passing oil plume in a way that a typical smooth soft bottom would not. The oil plume would pass over smooth soft bottom, continuing the process of biodegradation in mid-water and continuing to be dispersed over a wide area.

As of this writing, there are no data on the concentrations of hydrocarbons in sediments or on benthic community structure on the seafloor of the Gulf of Mexico after this event. There are, however, a few data available on hydrocarbons and dissolved oxygen levels in the water column. Water column data may be used to speculate the exposures benthic organisms may have experienced.

The hydrocarbon concentrations in the water column and subsea plume were close to, and below, the values reported by others for dispersed oil in the water column after oil spills. McAuliffe et al. (1981a) reported dispersed oil concentrations between 1 and 3 ppm at 9 m (30 ft) below the sea surface and 1 hour after treatment with dispersant. Lewis and Aurand (1997) reported dispersed oil concentrations <1 ppm at 10 m (33 ft) below the sea surface. Although McAuliffe et al. (1981a) and Lewis and Aurand (1997) did not address subsea plumes, the oil concentrations in the subsea plume appear to be similar to the concentrations reported from surface use of dispersants (Adcroft et al., 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010).

Water samples collected by the R/V *Weatherbird* on May 23-26, 2010, located 40 nmi (46 mi; 74 km) and 45 nmi (52 mi; 83 km) northeast and 142 nmi (163 mi; 263 km) southeast of the *Deepwater Horizon* rig revealed that concentrations of total petroleum hydrocarbons in the water column were <0.5 ppm (Haddad and Murawski, 2010). Concentrations of dispersed and dissolved oil in the subsea plume were reported to be in the part per million range or less and to decrease with distance from the wellhead (Adcroft et al., 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010). The available data suggest that the concentrations of oil in the water column were low and the oil was dispersed. These data suggest that, if any benthic organisms at the sediment/water interface were exposed to oil as a result of the DWH event, the concentrations were very low (in the part per million range or less).

Surveys performed by Camilli et al. (2010) delineated an underwater oil plume to the west-southwest of the DWH event site, a plume that extended over 35 km (22 mi) and concentrated at a depth of 1,100 m (3,600 ft). The plume was up to 200 m (650 ft) high and over 2 km (1.2 mi) wide in some areas. It was being moved by a water current at a depth of 1,100 m (3,600 ft) with an average speed of 7.8 cm/s^{-1} (0.26 ft/s^{-1}). Camilli et al. (2010) measured monoaromatic petroleum hydrocarbon concentrations in excess of 50 $\mu g/L^{-1}$ (>5 ppm) within the plume.

The OSAT report (2010) found quantitative results of PAH levels exceeding the aquatic benchmark and oil levels of 2,000-5,000 ppm in 6 percent of deepwater sediment samples; these elevated levels were within 3 km (2 mi) of the spill site.

Studies and data are continuing to be developed in response to the DWH event. This information will likely be developed through the NRDA process. Unavailable information on the effects to chemosynthetic communities from the DWH event may be relevant to reasonably foreseeable significant impacts on chemosynthetic communities. The NRDA process is investigating impacts to chemosynthetic communities, but information collected to date has not been made available to the public. It may be years before this information becomes available, and certainly not within the timeframe contemplated by this NEPA analysis. It is not within BOEM's ability to obtain this information, regardless of the costs involved. Nevertheless, BOEM believes that this incomplete or unavailable information would not be essential to a reasoned choice among alternatives because chemosynthetic communities are found throughout the Gulf and are in patchy distributions, minimizing the number that would be likely to be impacted by any single event. The BOEM subject-matter experts have included what credible scientific information is available and applied it using accepted scientific methodologies.

4.2.1.9.2. Impacts of Routine Events

Background/Information

Considerable mechanical damage could be inflicted upon deepwater chemosynthetic communities by routine OCS drilling activities associated with a CPA proposed action if mitigations are not applied. Bottom-disturbing activities associated with anchoring, structure emplacement, pipelaying, and structure removal cause localized bottom disturbances and disruption of benthic communities in the immediate area. Routine discharge of drill cuttings with associated muds can also affect the seafloor. Discharges on the sea surface of produced waters, chemical spills, and deck runoff would be diluted in surface waters, having no effect on seafloor habitats. Impacts from bottom-disturbing activities directly on chemosynthetic communities are expected to be extremely rare because of the application of required protective measures described by NTL 2009-G40. A detailed description of the possible impacts on chemosynthetic communities from routine activities associated with a CPA proposed action is presented below.

Anchoring and Structure Emplacement

The greatest potential physical disturbance is from anchor chains and cables. Deepwater work typically utilizes fewer anchors than work on the continental shelf. Because of the depths (over 300 m; 984 ft), pipelaying vessels and most drillships use dynamic positioning instead of anchors. This system uses computerized positioning controls of thrusters to maintain position of the vessel. Most platform structures use numerous large anchors and cables that are fixed in place for the duration of the service life of the structure. Some of these, particularly in ultra-deepwater (>1,000 m; 3,280 ft), also use dynamic positioning. Service vessels transiting supplies and personnel from shore typically dock on the working structure or ship rather than anchoring. The anchors themselves affect a relatively small area; the same is true for seafloor templates and other equipment on the seafloor. However, the chains and cables attached to anchors lay on the seafloor for some distance from the anchor. Depending on conditions and handling practices, this could extend several hundred meters from the anchor point during anchor setting, with lesser distances after tension is drawn on the anchor. The areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variation in wind and current directions. A 50-m (164-ft) radius of chain movement on the bottom around a mooring anchor could disturb the seafloor in an area of nearly 8,000 m^2 (2 ac). A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the floating drilling structure.

Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared with operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. However, many drillships, construction barges, and pipelaying vessels operating in deep waters of the Gulf of Mexico rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). New technologies, such as suction pile anchors, could also limit the area impacted by the anchors themselves. Anchoring would likely destroy sessile organisms actually contacted by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for substrate.

The area of disturbance resulting from anchoring and structure emplacement is small in absolute terms for the deepwater Gulf of Mexico. These impacts could cause considerable damage to dense chemosynthetic communities if placed directly on the habitats. Should this occur, it could result in recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering. The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities.

Pipelaying

Normal pipelaying activities in deepwater areas could damage chemosynthetic communities if pipelines, anchors, or cables are placed on the habitats. However, most pipelaying work in deepwater areas (>300 m; 984 ft) would utilize a dynamically positioned lay barge with no anchors or cables. If anchors are used, the cable sweep inherent in the progression of the barge affects more area than any other seafloor disturbance. Up to 12 large anchors are deployed at distances up to 2,500 m (8,202 ft) (depending on water depth). The cables are successively extended and drawn in to move the barge position forward as far as feasible before resetting the anchors and repeating the process. In this manner, the cables successively sweep large triangular areas of seafloor as the barge progresses. However, as stated above, this technique is usually not feasible in deep water.

Placement of the pipeline itself affects approximately 0.32 ha (0.79 ac) of bottom per kilometer (0.6 mi) of pipeline installed. Pipeline burial is not required in water depths greater than 60 m (200 ft). Pipeline placement with dynamically positioned barges would only affect sensitive deepwater communities if placed directly on the habitat. Since pipeline systems are not as established in deep water as in shallow water, new installations are required, which would tie into existing systems or (rarely) bring production directly to shore. Pipelines would also be required to transport product from subsea systems to fixed platforms.

The area of disturbance resulting from pipelaying activities is small in absolute terms for the deepwater Gulf of Mexico. These impacts could cause considerable damage to dense chemosynthetic communities if they occur directly on the habitats. Should this occur, it could result in recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering. The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities.

Structure Removal

In addition to physical impacts, structure-removal activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below. In deep water, the probability that infrastructure would be left on the seabed is likely higher. As one example, the ConocoPhillips Joliet platform was the first tension-leg platform in the GOM and was installed in 1986 at a depth of 537 m (1,762 ft) in Green Canyon Block 184. The subsea template was left in place after severing the tendons connecting the floating structure. This option virtually eliminates all bottom-disturbing impacts of structure removal. The review process would require avoidance of impacts to sensitive seafloor communities to prevent anchor impacts and any other seafloor disturbance as described in NTL 2009-G40.

Discharges

Chemosynthetic communities are susceptible to physical impacts from drilling discharges. In deep water, as opposed to shallower areas on the continental shelf, discharges of drilling fluids and cuttings at the sea surface are spread across broad areas of the seafloor and are generally distributed in thinner accumulations. A deepwater effects study funded by BOEM included determinations of the extent of muds and cuttings accumulations in approximately 1,000 m (3,281 ft) of water (CSA, 2006). Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within a 500-m (1,640-ft) radius of well sites. Sidescan-sonar showed areas of high reflectivity, interpreted as cuttings, extending in a radial pattern around the well sites. Generally, areas mapped as drilling muds were identified within about 100 m (328 ft) of well sites. Areas mapped as cuttings typically extended several hundred meters from well sites, with the greatest distance of about 1 km (0.6 mi) observed at two study sites. Geophysically mapped cuttings zones ranged from 13 to 109 ha (32 to 269 ac) in area. The geophysically mapped areal extent of cuttings was positively correlated ($r = 0.70$) with the total number of wells. Some increase in area due to multiple wells would be expected due to variations in current patterns over time as well as redistribution of the initial deposits of muds and cuttings. Studies have shown the thickness of muds and cuttings accumulations around well sites to range from about 20 to 25 cm (8 to 10 in) (Fechhelm et al. 1999; CSA, 2004b), with up to 45 cm (18 in) near a well measured in one study (CSA, 2006).

MacDonald et al. (1995) indicate that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. The primary concern related to muds and cuttings discharges is that of burial. Chemosynthetic organisms do not use photosynthesis but they do require oxygen to live. Complete burial by sediments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms. Clams are motile and may remain above the accumulating sediment. Tube worms are partially buried in sediment as their normal habit but typically have a substantial portion of the tube above the sediment. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Some can reach total lengths of up to 3 m (10 ft) (Fisher, 1995; Fisher et al., 1997; Bergquist et al., 2000). Since the branchial plume at the upper tip of the tube is used for gas exchange, their chance for surviving sediment accumulations is enhanced. The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

The potential impacts of accumulated drilling muds and cuttings are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive seafloor habitats are avoided. With the application of NTL 2009-G40, it is expected that no chemosynthetic communities would be located closer than 610 m (2,000 ft) from the surface location of any muds and cuttings discharges.

Proposed Action Analysis

Chemosynthetic communities may be found in the CPA subareas that include waters ≥300 m (984 ft), i.e., offshore Subareas C200-800, C800-1600, C1600-2400, and C>2400 m (**Figure 3-1**). The levels of projected activity in these subareas as a result of a CPA proposed action are shown in **Tables 3-3 and 3-6**. A typical lease sale is expected to result in the following for the relevant subareas: 82-162 exploration wells; 105-207 development wells; and 4-7 production structures. The BOEM OCS Program activities in the CPA up through this Five-Year Program are expected to result in the following for the years 2012-2051: 2,670-3,790 exploration wells; 3,300-4,680 development wells; and 100-120 production structures. Production structures would range from small subsea developments to large developments involving floating, fixed, or subsea structures.

The NTL 2009-G40 describes BOEM policy to search for and avoid dense chemosynthetic communities or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The policies in the NTL are exercised on all leases and are applied as required mitigation measures to protect the habitats. Under the provisions described in BSEE NTL's, lessees operating in water depths greater than 300 m (984 ft) are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities; if such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities. The required buffer distance of separation between potential high-density chemosynthetic communities and drilling discharge points is 610 m (2,000 ft); the buffer for all other seafloor disturbances is 75 m (250 ft). If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place within the buffer area; if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid (rather than photodocument) any areas that show the potential to support chemosynthetic communities.

Impacts from bottom-disturbing activities directly on chemosynthetic communities are expected to be extremely rare because of the application of required protective measures as described by NTL 2009-G40. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering. The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure or pipeline emplacement.

Summary and Conclusion

Chemosynthetic communities are susceptible to physical impacts from anchoring, structure emplacement, pipeline installation, structure removal, and drilling discharges. Without mitigation measures, these activities could result in smothering by the suspension of sediments or the crushing of organisms residing in these communities. Because of the avoidance policies described in NTL 2009-G40, the risk of these physical impacts are greatly reduced by requiring the avoidance of potential chemosynthetic communities. Information included in required hazards surveys for oil and gas activities depicts areas that could potentially harbor chemosynthetic communities. This allows BOEM to require avoidance of any areas that are conducive to chemosynthetic growth. If a high-density community is subjected to direct impacts by bottom-disturbing activities, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage.

Routine activities of a CPA proposed action are expected to cause no damage to the ecological function or biological productivity of chemosynthetic communities. Widely scattered, high-density chemosynthetic communities would not be expected to experience impacts from oil and gas activities in deep water because the impacts would be limited by standard BOEM protections in place, as described in NTL 2009-G40. Impacts on chemosynthetic communities from routine activities associated with a CPA proposed action would be minimal to none.

4.2.1.9.3. Impacts of Accidental Events

Background/Introduction

Accidental events that could impact chemosynthetic communities are primarily limited to seafloor blowouts. A blowout at the seafloor could create a crater and could resuspend and disperse large quantities of bottom sediments within a 300-m (984-ft) radius from the blowout site. This could bury organisms located within that distance to some degree. The application of avoidance criteria for chemosynthetic communities described in NTL 2009-G40 precludes the placement of a well within 610 m (2,000 ft) of any suspected site of a chemosynthetic community, therefore distancing the chemosynthetic community from sedimentation resulting from a possible blowout.

All known reserves in the Gulf of Mexico have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. As discussed in **Chapter 3.2.1.5.4**, oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column and surface almost directly over the source location, thus not impacting sensitive deepwater communities. Therefore, the oil is expected to rise to the sea surface under natural conditions. This behavior is modified when dispersants are applied to the oil on the sea surface or at depth, causing the oil to mix with water. Some oil can also be broken into tiny droplets that disperse with the water currents when the oil is ejected under high pressure. The dispersed oil then begins to biodegrade and may flocculate with particulate matter in the water column, promoting sinking of the particles.

Oil and chemical spills that originate at the sea surface are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink and the risk of weathered components of a surface slick reaching the benthos in any measurable concentration would be very small. Surface oil also could not physically mix to depths of chemosynthetic communities under natural conditions (Lange, 1985; McAuliffe et al., 1975; McAuliffe et al., 1981a; Tkalich and Chan, 2002).

There is some reason to believe the presence of oil would have limited effect on chemosynthetic organisms because these communities live among oil and gas seeps; however, natural seepage is very constant and at very low rates as compared with the potential volume of oil released from a blowout or pipeline rupture. In addition, organisms inhabit certain niches within the gradients found at oil seeps, choosing locations with enough hydrocarbons to sustain their metabolism but not enough to be toxic. All seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources. Oil plumes that contact the seafloor before degrading could potentially affect sensitive benthic communities if they happen to encounter such a habitat in a localized area.

Studies indicate that periods as long as hundreds of years are required to reestablish a chemosynthetic seep community once it has disappeared (depending on the community type); although it may reappear relatively quickly once the process begins, as in the case of mussel communities (Powell, 1995; Fisher, 1995). Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old (Fisher, 1995). There is evidence that substantial impacts on these communities could permanently prevent reestablishment, particularly if the hard substrate required for recolonization should become buried.

Proposed Action Analysis

The application of BOEM avoidance criteria policies for chemosynthetic communities described in detail in NTL 2009-G40 should preclude any impact from a blowout by maintaining a minimum buffer distance of 610 m (2,000 ft), which is beyond the distance of expected benthic disturbance. Low concentrations of resuspended bottom sediments transported by near-bottom currents could reach chemosynthetic communities located beyond 610 m (2,000 ft) and potentially deposit some sediment on the organisms; however, at this distance, sediments would be dispersed, reducing the concentration to which chemosynthetic communities may be exposed.

The risk of various sizes of oil spills occurring as a result of a CPA proposed action is presented in **Table 3-12**. The possibility of a spill ≥1,000 bbl resulting from a CPA proposed action is estimated to be up to one spill in the 40-year period (2012-2051). The possibility of oil from a surface spill reaching depth of 300 m (984 ft) or greater in any measurable concentration is very small. Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10 m (33 ft). Modeling studies have shown oil could mix to 20 m (66 ft) in the water column (Lange, 1985; McAuliffe et al., 1975; McAuliffe et al., 1981a; Tkalich and Chan, 2002). The results of field measurements and modeling exercises indicate that oil cannot physically mix under natural conditions to the depth of chemosynthetic communities, which should protect them from surface oil.

A catastrophic spill, like the DWH event, could affect chemosynthetic community habitat. If dispersants are applied to an oil spill at depth or if oil is ejected into deep water under high pressure (resulting in vigorous turbulence and the formation of micro-droplets), oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor where it may impact patches of sensitive deepwater community habitat in its path. The use of dispersant causes oil to mix with the water and travel laterally with water currents, ultimately leading to precipitation on the seafloor in some form (Whittle et al., 1982; ITOPF, 2002). Lubchenco et al. (2010) reports that chemically dispersed surface oil from the DWH event remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. This seems reasonable since dispersant usage reduces the oil's ability to adhere to particles in the water column, slowing its rate of precipitation to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997) and oil droplets remain neutrally buoyant in the water column, creating a subsurface plume of oil (Adcroft et al., 2010). Since oil plumes would be carried by underwater currents, the impacts would be distributed from the source toward the direction that the water currents travel. Oil exposed to dispersant chemicals also becomes more dispersed and less concentrated the longer it remains floating or suspended in the water column. Oil treated with dispersant at depth can mix with the water column and potentially be carried by currents to contact chemosynthetic communities. Oil plumes reaching chemosynthetic communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. These potential impacts would be localized because of the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. Concentrations of dispersed and dissolved oil in the DWH subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010). Depending on how long it remains in the water column, oil may be thoroughly degraded by biological action before contact with the seafloor. Water currents can carry a plume to contact the seafloor directly but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston, 1995; ITOPF, 2002). Oil also would reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Habitats directly in the path of the oil plume when the oil contacts the seafloor would be affected, but most oil would reach the seafloor in a widely scattered and decayed state. In addition, sublethal effects are possible for communities that receive a lower level of impact. These effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, loss of tissue mass, and similar effects (Rogers, 1990; Jackson et al., 1989; Frithsen et al., 1985; Cohen et al., 1977; Loya, 1976a).

Summary and Conclusion

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The guidance provided in NTL 2009-G40 greatly reduces the risk of these physical impacts by requiring a buffer of 610 m (2,000 ft) from wells. It clarifies the requirement to avoid potential chemosynthetic communities identified on the required geophysical survey records or photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement. The 2,000-ft (610-m) avoidance required would protect sensitive communities from heavy sedimentation, with only light sediment components able to reach the communities in small quantities.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type) (Powell, 1995; Fisher, 1995). There is evidence that substantial impacts on these communities could permanently prevent reestablishment, particularly if hard substrate required for recolonization is buried by resuspended sediments from a blowout.

Potential accidental impacts from a CPA proposed action are expected to cause little damage to the ecological function or biological productivity of widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density chemosynthetic communities located at more than 610 m (2,000 ft) away from a blowout could experience minor impacts from resuspended sediments that travel with currents, although the sediment concentration would be diluted with distance from the well. The possibility of oil from a surface spill reaching depth of 300 m (984 ft) or greater in any measurable concentration is very small. If dispersants are applied to an oil spill, oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor in some form, either concentrated (near the source) or decayed (farther from the source), where it may impact patches of chemosynthetic community habitat in its path. As with sediments, the farther the dispersed oil travels, the more diluted it will become as it mixes with surrounding water.

Accidental impacts associated with a CPA proposed action would result in only minimal impacts to chemosynthetic communities with adherence to the proposed biological stipulation and the guidelines described in NTL 2009-G40. One exception would be in the case of a catastrophic spill (**Appendix B**) combined with the application of dispersant, producing the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. The possible impacts, however, would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect. If such an event were to occur, it could take hundreds of years to reestablish the chemosynthetic community in that location.

4.2.1.9.4. Cumulative Impacts

Background/Introduction

Cumulative factors considered to impact the deepwater benthic communities (>300 m; 984 ft) of the Gulf of Mexico include both oil- and gas-related and non-oil- and non-gas-related activities. The latter type of impacting factors include activities such as fishing and trawling at a relatively small scale, and large-scale factors such as storm impacts and climate change. There are essentially only three fish (or "shellfish") species considered important to deepwater commercial bottom fisheries—the yellowedge grouper, tilefish, and royal red shrimp.

Yellowedge grouper habitat extends to about 275 m (902 ft). Bottom longlining for tilefish could potentially result in cumulative impact to deepwater communities, as their habitat in the GOM extends to 540 m (1,772 ft) (FishBase, 2006). If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. De Forges et al. (2000) reports threats to deepwater biological communities by fishing activity off New Zealand. In the 1980's when the orange roughy fishery exploded off New Zealand, catches from aggregations around deep-sea seamounts sometimes retrieved 60 tons of fish from a 20-minute trawl. After just 10 years, the fishery collapsed to less than 20 percent of the pre-exploited abundance. Species similar to the targeted species in Australia and New Zealand (e.g., the orange roughy [genus *Hoplostethus*]), do occur in the GOM; however, they are not abundant and are smaller in size. There is no information that this group of deep-sea fish has been exploited in the Gulf of Mexico. This is very fortunate because of the extensive destruction that would be caused to associated deepwater hard bottom associated with *Hoplostethus* preferred habitat. In the GOM, this is most always authigenic carbonate and likely also associated with potential chemosynthetic communities or deepwater coral communities.

The royal red shrimp is fished in some areas of the Gulf. Its depth range spans 180-730 m (591-2,395 ft), but most are obtained from depths of 250-475 m (820-1,558 ft) in the northeastern part of the Gulf of Mexico (GMFMC, 2004b). This species is obtained from trawling using traditional but modified shrimp trawls. The use of traps for royal red shrimp was prohibited in Amendment 11 of the Shrimp Fishery Management Plan (GMFMC, 2006a). If trawling occurred in sensitive areas of deepwater habitats, extensive damage to those communities could occur, but the areas where royal red shrimp are obtained are not known for hard-bottom communities, and the shrimp prefer soft bottom composed of sand, clay, or mud (CSA, 2002). Unlike other areas in the Atlantic and in Europe, bottom fishing and trawling efforts in the deeper water of the CPA are currently minimal, and impacts to deepwater benthic communities are negligible.

Other regional non-oil- and non-gas-related sources of cumulative impact to deepwater benthic communities would be possible, but they are considered unlikely to occur. Essentially no anchoring from non-OCS-related activities occurs at the deeper water depths considered for these resources (>300 m; 984 ft). Some impacts are highly unlikely yet not impossible, such as the sinking of a ship or barge resulting in collision or contaminant release directly on top of a sensitive, high-density chemosynthetic community.

The greatest potential for cumulative adverse impacts to occur to the deepwater benthic communities would come from those OCS-related, bottom-disturbing activities associated with pipeline and platform emplacement (including templates and subsea completions), associated anchoring activities, discharges of muds and cuttings, and seafloor blowout accidents.

As exploration and development continue on the Federal OCS, activities have moved farther into the deeper water areas of the Gulf of Mexico. With this trend comes the certainty that increased development would occur on discoveries throughout the entire depth range of the CPA; these activities would be accompanied by limited unavoidable impacts to the soft-bottom deepwater benthos from bottom disturbances and disruption of the seafloor from associated activities. The extent of these disturbances would be determined by the intensity of development in these deepwater regions, the types of structures and mooring systems used, and the effective application of the avoidance criteria as described in NTL 2009-G40 (USDOI, MMS, 2009b). All activity levels for the cumulative scenario in the CPA for the years 2012-2051 are shown in **Table 3-6**. For the CPA deepwater offshore Subareas C200-800, C800-1600, C1600-2400, and C>2400, there are currently an estimated 2,670-3,790 exploration and delineation wells and 3,300-4,680 development and production wells to be drilled and 100-120 production structures to be installed through the 40-year analysis period.

Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths >300 m (984 ft) as indicated in a major deepwater effects study funded by BOEM and completed in 2006—*Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico* (CSA, 2006). This project included determinations of the extent of muds and cuttings accumulations resulting from both exploratory and development drilling at three sites in approximately 1,000 m (3,281 ft) of water. Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within the 500-m (1,640-ft) radius of what was termed near-field stations. Generally, areas mapped as drilling muds were identified within about 100 m (328 ft) of well sites. Areas mapped as cuttings typically extended several hundred meters from well sites. Potential local cumulative impacts could result from accumulations of muds and cuttings resulting from consistent hydrographic conditions and drilling of multiple wells from the same location, causing concentrations of material in a single direction or "splay." It is not expected that detectable levels of muds and cuttings discharges from separate developments or from adjacent lease blocks would act as a cumulative impact to deepwater benthic communities. Physical separation of well sites, great water depths, and adherence to the policies described in NTL 2009-G40, which precludes well development within 610 m (2,000 ft) of any suspected site of a deepwater benthic community, prevent separate activities from having overlapping effects.

The majority of deepwater chemosynthetic communities are of low density and are widespread throughout the deepwater areas of the Gulf. Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The frequency of such impact is expected to be low. Physical disturbance to a small area would not result in a major impact to the ecosystem. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density communities are widely distributed but they are few in number and limited in size. They have a high standing biomass and productivity. High-density chemosynthetic communities would be largely protected by NTL 2009-G40, which serves to prevent impacts by requiring avoidance of potential chemosynthetic communities identified by association with geophysical characteristics or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure or anchor placements.

Numerous new chemosynthetic communities were discovered and explored using the submersible *Alvin* in 2006 and with the remotely operated vehicle *Jason II* in 2007 as part of the recent Agency-funded study, *Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico: Interim Report 2* (Brooks et al., 2009). These new communities were targeted using the same procedures integral to the biological review process. The BOEM policies described in NTL 2009-G40 require that target areas of potential communities be avoided by impacting oil and gas activities.

Small impacts are expected to occur infrequently, but the impacts from bottom-disturbing activities, if they occur, could be quite severe to the immediate area affected. If it occurred, the disturbance could lead to the destruction of a high-density chemosynthetic community from which recovery would occur only over long intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or it would not occur at all. Other possible sublethal effects could include incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the immediate area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events. Subsea structure removals are not expected in water depths >800 m (2,625 ft), in accordance with 30 CFR 250. The distance of separation required by adherence to the policies described in NTL 2009-G40 would protect chemosynthetic communities from sedimentation effects of deepwater blowouts.

The use of dispersants on surface oil is not anticipated to impact chemosynthetic communities. It is reported that chemically dispersed surface oil from the DWH event remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded (Lubchenco et al., 2010). Data from other studies on dispersant usage on surface plumes indicate that a majority of the dispersed oil remained in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Therefore, oil spills on the sea surface are expected to have little to no effect on deepwater benthic communities.

However, subsea oil plumes resulting from a seafloor blowout could affect sensitive deepwater communities. This could happen if oil is ejected into deep water under high pressure, resulting in vigorous turbulence and the formation of micro-droplets, but it is especially true if dispersants are applied at depth. A recent report documents damage to a deepwater coral community in an area that oil plume models predicted as the direction of travel for subsea oil plumes from the DWH event. Results are still pending but it appears that a coral community about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged, possibly the result of oil impacts (USDOI, BOEMRE, 2010j). Such blowouts are rare and may not release catastrophic quantities of oil. Oil that is released underwater would normally rise rapidly to the sea surface. However, if oil is ejected into deep water under high pressure, a plume of micro-droplets of oil can form. Treatment of the oil with dispersants at depth would also form a plume of oil that would be carried in whatever direction the water currents flow.

This directional flow could only affect seafloor habitats that are downstream from the source. Although the oil plume could be carried into direct contact with the seafloor at some distance from the source, a more likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; ITOPF, 2002). Oil would also reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Dispersant reduces the oil's ability to adhere to particles in the water column, slowing its rate of precipitation to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997), and oil droplets remain neutrally buoyant in the water column, creating a subsurface plume of oil (Adcroft et al., 2010). These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Sensitive deepwater communities appear to be widely scattered and not as rare as previously expected. Recent BOEM analyses of seafloor remote-sensing data indicate over 16,000 locations in the deep GOM that represent potential hard-bottom habitats (Shedd et al., 2011). While it is likely that any subsea oil plume traveling more than a few miles on the deep seafloor would cross at least one of these potential habitats, the plume may not contact the seafloor at that point. If the plume did contact the seafloor, it would result in a localized effect that is not expected to alter the wider population of the GOM.

In cases where high-density communities are subjected to greatly dispersed discharges or suspended sediments, the impacts are most likely to be sublethal in nature and limited in areal extent. The impacts to ecological function of high-density communities would be minor; minor impacts to ecological relationships with the surrounding benthos would also be likely.

Because of the great water depths, treated sanitary wastes and produced waters are not expected to have any adverse cumulative impacts to any deepwater benthic communities. These effluents would undergo a great deal of dilution and dispersion before reaching the bottom (if ever).

Oil and chemical spills on the sea surface (potentially from non-OCS-related activities) are not considered to be a potential source of measurable impacts on any deepwater communities because of water depth. Oil spills from the surface would tend to float. Oil discharges at depth or on the bottom would tend to rise in the water column and similarly not impact the benthos unless dispersants are applied at depth. In the case of chemosynthetic communities, there is also reason to expect that animals are resistant to at least low concentrations of dissolved hydrocarbons in the water, as communities are typically found growing in oil-saturated sediments and in the immediate vicinity of active oil and gas seeps.

Summary and Conclusion

Cumulative impacts to deepwater communities in the Gulf of Mexico are considered negligible because of their remoteness from most impacts and because of the application of the BOEM avoidance criteria as described in NTL 2009-G40. The most serious, impact-producing factor threatening chemosynthetic communities is physical disturbance of the seafloor, which could destroy the organisms of these communities. Such disturbance would most likely come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to chemosynthetic communities, but substantial accumulations could result in more serious impacts. Seafloor disturbance is considered to be a threat only to the high-density communities; widely distributed low-density communities would not be at risk. Possible catastrophic oil spills due to seafloor blowouts have the potential to devastate localized deepwater benthic habitats. However, these events are rare and would only affect a small portion of the sensitive benthic habitat in the GOM. Recent analyses reveal over 15,000 possible hard-bottom locations across the deepwater GOM. Guidance provided in NTL 2009-G40 describes required surveys and avoidance prior to drilling or pipeline installation and would greatly reduce risk. New studies have refined predictive information and confirmed the effectiveness of these provisions throughout all depth ranges of the Gulf of Mexico (Brooks et al., 2009). With the dramatic success of this project, confidence is increasing regarding the use of geophysical signatures for the prediction of chemosynthetic communities.

Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths in these areas (>300 m; 984 ft) and the low density of potentially commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes. Regionwide and even global impacts from CO_2 build-up and proposed methods to sequester carbon in the deep sea (e.g., ocean fertilization) are not expected to have major impacts to deepwater habitats in the near future. More distant scenarios could include severe impacts.

The proposed activities in the CPA considered under the cumulative scenario are not expected to cause damage to the ecological function or biological productivity of widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density chemosynthetic communities could experience isolated minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years, but even minor impacts are not expected. Major impacts to localized benthic habitat are possible in the event of a catastrophic blowout on the seafloor, particularly when chemical dispersants are applied to oil releases at depth. If physical disturbance (such as anchor damage) or extensive burial by muds and cuttings were to occur to high-density communities, impacts could be severe, with recovery time as long as 200 years for mature tube-worm communities. There is evidence that substantial impacts on these communities could permanently prevent reestablishment. Other sublethal impacts include possible incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Although OCS activities are the primary impact-producing factors for these communities, the incremental contribution of a CPA proposed action to cumulative impacts is expected to be minimal. The BOEM's protective measures would minimize the possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension or drill cutting discharges through avoidance. Adverse impacts would be limited but not completely eliminated by adherence to guidelines in NTL 2009-G40.

4.2.1.10. Nonchemosynthetic Deepwater Benthic Communities

4.2.1.10.1. Description of the Affected Environment

Deepwater Coral Benthic Communities

Deepwater corals are relatively rare examples of deepwater communities that would not be expected considering the fact that the vast majority of the deep GOM continental slope is made up of soft silt and clay sediments. Typical hermatypic (reef-building) corals contain photosynthetic algae and cannot live in deepwater environments; however, many ahermatypic corals can live on suitable substrates (hardgrounds) in these environments. Scleractinian corals are recognized in deepwater habitats, but there is little information regarding their distribution or abundance in the Gulf (USDOI, MMS, 2000a, p. IV-14). Scleractinian corals may occupy isolated hard-bottom habitats but usually occur in association with high-density chemosynthetic communities that often are situated on carbonate hardgrounds.

Deepwater coral communities are now known to occur in many locations in the deep GOM (>300 m; 984 ft); one example is represented by what was reported as a deepwater coral reef by Moore and Bullis (1960). In an area measuring 300 m (984 ft) in length and more than 20 nmi (23 mi; 37 km) from the nearest known chemosynthetic community (likely in Viosca Knoll Block 906), a 1955 trawl collection from a depth of 421-512 m (1,381-1,680 ft) retrieved more than 300 lb (136 kg) of the scleractinian coral *Lophelia pertusa*.

The "rediscovery" of the Moore and Bullis site was notable. Prior to a *NR 1* Navy submersible cruise in 2002, there was a need to identify potential study sites for deepwater corals. The location sampled by Moore and Bullis had not been revisited since their trawl in 1955. The rough location given in their paper (29°5' N. latitude, 88°19' W. longitude; Moore and Bullis, 1960) was located in a soft-bottom environment. A biologist with BOEM used this location as a starting point to identify a target site utilizing the BOEM in-house, 3D seismic database depicting seafloor bathymetry and hard-bottom features in the region. Approximately 5 nmi (6 mi; 9 km) to the west of the published location, there was a striking set of features, including a narrow canyon that closely matched the fathometer tracing and depth of a feature illustrated in Moore and Bullis (1960). A number of potential high-reflectivity target locations across the canyon were provided for the *NR 1* project. Although no *Lophelia* coral was found in the canyon, a spectacular habitat including *Lophelia* and a variety of antipatharian "black corals" (some up to 3 m [9.8 ft] in height) was found while investigating the shallowest of the hard-bottom features located nearby in Viosca Knoll Block 862. It is not known if this peak was along the Moore and Bullis trawl track.

Additional research recently released by BOEMRE further reinforces the idea that there are many more potential deepwater live-bottom sites than previously expected. Analyses of seafloor seismic data by BOEMRE geophysicists have revealed over 21,000 seafloor seismic amplitude anomalies. These are areas of anomalously high or low seafloor reflectivity. They represent three categories of seafloor features: (1) high positive amplitudes indicative of carbonate hard bottoms produced by chemosynthetic bacterial activity; (2) low positive to negative anomalies due to high flux of hydrocarbons, usually producing mud volcanoes or flows of mud downslope and possible chemosynthetic activity; and (3) pockmarks that likely result from explosive release of gases from the seafloor. The third category is not associated with chemosynthetic activity, but the first two are expected to represent possible chemosynthetic and deepwater coral communities. The high positive anomalies show high reflectance due to the presence of hard-bottom areas. These hard bottoms are created by the precipitation of calcium carbonate substrate through chemosynthetic bacterial activity. These high reflectance areas are likely to support chemosynthetic communities along with possible deepwater coral communities. The low positive anomalies represent areas with a high flux of hydrocarbons. Such areas often have too much flow to be conducive to development of chemosynthetic communities. However, chemosynthetic bacteria and clams may colonize portions of the area. **Figure 4-9** shows polygons for the locations of high and low positive/negative anomalies representing possible chemosynthetic and deep coral communities (USDOI, BOEMRE, 2011c).

Deepwater coral habitats have been shown to be much more extensive and important to the support of diverse communities of associated fauna than previously known in the GOM. Although *Lophelia* is best represented in water depths of the upper slope, it has been reported as deep as 3,000 m (9,842 ft) in some parts of the world. Additional studies funded by BOEM are in progress or in earlier stages of development that will further investigate the distribution of deepwater corals and other important nonchemosynthetic communities in the deep GOM. Considering the depth of this resource, >300 m (984 ft), these deepwater communities would be beyond the impacts from severe storms or hurricanes, and there has been no alteration of these communities caused from surface storms, including the severe 2005 hurricane season.

Deepwater Horizon Event

The DWH event released an estimated 4.9 MMbbl of oil from the well over an 87-day period following the event. Extensive literature, Internet, and database searches have been conducted for results of scientific data. Although many research cruises have occurred, very few scientific analyses have been published as of this writing. Descriptions of studies completed or in progress are discussed in the previous section on chemosynthetic communities (**Chapter 4.2.1.9**). Possible impacts to nonchemosynthetic communities are discussed below.

Much of the oil was treated with dispersant at the sea surface and at the source in 1,500-m (5,000-ft) water depth. The dispersed oil mixed with the water; its movement was dictated by water currents, density, and the physical processes of degradation. Because deepwater corals and other live bottoms occur in locations where carbonate substrate has been precipitated by the action of chemosynthetic organisms, the mechanisms that could bring oil in contact with each community are the same. A full discussion of the fate and behavior of oil from the DWH event on chemosynthetic communities can be found in **Chapter 4.2.1.9**. Depending on how long it remained in the water column, subsea oil plumes may have been well-dispersed and thoroughly degraded by biological action before contact with the seafloor.

There have been no experiments showing the response of deepwater corals to oil exposure. Experiments with shallow tropical scleractinian corals indicate that corals have a high tolerance to oil exposure. The mucus layers on coral resist penetration of oil and slough off the contaminant. Longer exposure times and areas of tissue where oil adheres to the coral are more likely to result in tissue damage and death of polyps. Corals with branching growth forms appear to be more susceptible to damage from oil exposure (Shigenaka, 2001). The most common deepwater coral, *Lophelia pertusa*, is also a branching species. In addition, tests on a shallow, tropical soft coral indicate relatively low toxic effects to the coral, suggesting that deepwater soft corals may have a similar response (Cohen et al., 1977). Deepwater coral response to exposure to oil from the DWH event would vary, depending on the level of exposure. A recent report documents damage to a deepwater coral community in the CPA in an area that oil plume models predict as the direction of travel for subsea oil plumes from the DWH event. Results are still pending, but it appears that a coral community about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged, possibly the result of oil impacts (USDOI, BOEMRE, 2010j). Coral forms structures that protrude up into the water column above the seafloor, making them more susceptible to impacts from a passing oil plume. Research projects are continuing to investigate areas around the DWH event to assess the impacts.

Communities exposed to concentrated oil may have experienced detrimental effects including death of affected organisms, tissue damage, lack of growth, interruption of reproductive cycles, and loss of gametes. Median levels of exposure to dispersed oil in a partly degraded condition may have resulted in effects similar to those for shallow tropical corals, with often no discernible effects other than temporary contraction and some sloughing. Exposure to widely dispersed oil adhering to organic detritus and partially degraded by bacteria may be expected to result in little effect. Health of corals may have been degraded by the necessary expenditure of energy as the corals respond to oiling. Coral exposure to lower concentrations of oil may have resulted in sublethal impacts such as altered reproduction, growth, respiration, excretion, chemoreception, feeding, movement, stimulus response, and susceptibility to disease (Suchanek, 1993). Many invertebrates associated with deepwater coral communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure. Recolonization of severely damaged or destroyed communities could take years to decades.

Studies and data are continuing to be developed in response to the DWH event. This information will likely be developed through the NRDA process. Unavailable information on the effects to nonchemosynthetic communities from the DWH event may be relevant to reasonably foreseeable significant impacts. The NRDA process is investigating impacts to nonchemosynthetic communities, but information collected to date has not been made available to the public. It may be years before this information becomes available, and certainly not within the timeframe contemplated by this NEPA analysis. It is not within BOEM's ability to obtain this information, regardless of the costs involved. Nevertheless, BOEM believes that this incomplete or unavailable information would not be essential to a reasoned choice among alternatives because nonchemosynthetic communities are found throughout the Gulf and are in patchy distributions, minimizing the number that would be likely to be impacted by any single event. In addition, available data indicate significant impacts to one coral community; these impacts were only identified in one location 7 mi (11 km) downcurrent from the Macondo well site. The BOEM subject-matter experts have included what credible scientific information is available and applied it using accepted scientific methodologies.

4.2.1.10.2. Impacts of Routine Events

Considerable mechanical damage could be inflicted upon sensitive nonchemosynthetic deepwater benthic communities by routine OCS drilling activities associated with a CPA proposed action if mitigations are not applied. Deepwater live-bottom communities, primarily structured by the coral *Lophelia pertusa*, are the nonchemosynthetic deepwater benthic communities that would be sensitive to impacts from oil and gas activities. Bottom-disturbing activities associated with anchoring, structure emplacement, pipelaying, and structure removal cause localized bottom disturbances and disruption of benthic communities in the localized areas. Routine discharge of drill cuttings with associated muds can also affect the seafloor. Discharges on the sea surface of produced waters, chemical spills, and deck runoff would be diluted in surface waters, having no effect on seafloor habitats. Impacts from bottom-disturbing activities directly on deepwater coral communities are expected to be extremely rare because of the application of required protective measures described by NTL 2009-G40. A detailed description of the possible impacts on deepwater coral communities from routine activities associated with a CPA proposed action is presented below.

Anchoring and Structure Emplacement

The greatest potential physical disturbance is from anchor chains and cables. Deepwater work typically utilizes fewer anchors than work on the continental shelf. Because of the depths (over 300 m; 984 ft), pipelaying vessels and most drillships use dynamic positioning instead of anchors. This system uses computerized positioning controls of thrusters to maintain position of the vessel. Most platform structures use numerous large anchors and cables that are fixed in place for the duration of the service life of the structure. Some of these, particularly in ultra-deepwater (over 1,000 m; 3,280 ft), also use dynamic positioning. Service vessels transiting supplies and personnel from shore typically dock on the working structure or ship rather than anchoring. The anchors themselves affect a relatively small area; the same is true for seafloor templates and other equipment on the seafloor. However, the chains and cables attached to anchors lay on the seafloor for some distance from the anchor. Depending on conditions and handling practices, this could extend several hundred meters from the anchor point during anchor setting, with lesser distances after tension is drawn on the anchor. The areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variation in wind and current directions. A 50-m (164-ft) radius of chain movement on the bottom around a mooring anchor could disturb the seafloor in an area of nearly 8,000 m^2 (2 ac). A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the floating drilling structure.

Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared with operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. However, many drillships, construction barges, and pipelaying vessels operating in deep waters of the Gulf of Mexico rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). New technologies, such as suction pile anchors, could also limit the area impacted by the anchors themselves. Anchoring would likely destroy sessile organisms actually contacted by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for substrate.

The area of disturbance resulting from anchoring and structure emplacement is small in absolute terms for the deepwater Gulf of Mexico. These impacts could cause considerable damage to deepwater coral communities if placed directly on the habitats. Should this occur, it could result in recovery times in the order of decades or more with the possibility of the community never recovering (Food and Agriculture Organization of the United Nations, 2008; Jones, 1992; Probert et al., 1997). The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring avoidance of potential deep-sea coral communities.

Pipelaying

Normal pipelaying activities in deepwater areas could damage coral communities if pipelines, anchors, or cables are placed on the habitats. However, most pipelaying work in deepwater areas (>300 m; 980 ft) would utilize a dynamically positioned lay barge with no anchors or cables. If anchors are used, the cable sweep inherent in the progression of the barge affects more area than any other seafloor disturbance. Up to 12 large anchors are deployed at distances up to 2,500 m (8,202 ft) (depending on water depth). The cables are successively extended and drawn in to move the barge position forward as far as feasible before resetting the anchors and repeating the process. In this manner, the cables successively sweep large triangular areas of seafloor as the barge progresses. However, as stated above, this technique is usually not feasible in deep water.

Placement of the pipeline itself affects approximately 0.32 ha (0.79 ac) of bottom per kilometer (0.62 mi) of pipeline installed. Pipeline burial is not required in water depths >60 m (200 ft). Pipeline placement with dynamically positioned barges would only affect sensitive deepwater coral communities if placed directly on the habitat. Since pipeline systems are not as established in deep water as in shallow water, new installations are required, which would tie into existing systems or (rarely) bring production directly to shore. Pipelines would also be required to transport product from subsea systems to fixed platforms.

The area of disturbance resulting from pipelaying activities is small in absolute terms for the deepwater Gulf of Mexico. These impacts could cause considerable damage to deepwater coral communities if they occur directly on the habitats. Should this occur, it could result in recovery times in the order of decades or more with the possibility of the community never recovering (Food and Agriculture Organization of the United Nations, 2008; Jones, 1992; Probert et al., 1997). The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring avoidance of potential deepwater coral communities.

Structure Removal

In addition to physical impacts, structure-removal activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below. In deep water, the probability that infrastructure would be left on the seabed is likely higher. As one example, the ConocoPhillips Joliet platform was the first tension-leg platform in the GOM and was installed in 1986 at a depth of 537 m (1,762 ft) in Green Canyon Block 184. The subsea template was left in place after severing the tendons connecting the floating structure. This option virtually eliminates all bottom-disturbing impacts of structure removal. The review process would require avoidance of impacts to sensitive seafloor communities to prevent anchor impacts and any other seafloor disturbance as described in NTL 2009-G40.

Discharges

Deepwater live-bottom communities are susceptible to physical impacts from drilling discharges. In deep water, as opposed to shallower areas on the continental shelf, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are generally distributed in thinner accumulations. The result of this dispersion is that seafloor habitats receive little additional sedimentation from drilling discharges in areas where it settles to the seafloor. Small amounts of sedimentation are normal for these environments.

A deepwater effects study funded by BOEMRE included determinations of the extent of muds and cuttings accumulations in approximately 1,000 m (3,281 ft) of water (CSA, 2006). Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within a 500-m (1,640-ft) radius of well sites. Sidescan-sonar showed areas of high reflectivity, interpreted as cuttings, extending in a radial pattern around the well sites. Generally, areas mapped as drilling muds were identified within about 100 m (328 ft) of well sites. Areas mapped as cuttings typically extended several hundred meters from well sites, with the greatest distance of about 1 km (0.6 mi) observed at two study sites. Geophysically mapped cuttings zones ranged from 13 to 109 ha (32 to 269 ac) in area across all study sites. The geophysically mapped areal extent of cuttings was positively correlated (r = 0.70) with the total number of wells. Some increase in area due to multiple wells would be expected due to variations in current patterns over time, as well as redistribution of the initial deposits of muds and cuttings. That is, more wells drilled at a single location results in more cuttings over a longer time period and is subject to more variation in water currents, therefore resulting in a larger area of sedimentation. Studies have shown the thickness of muds and cuttings accumulations around well sites to range from about 20 to 25 cm (8-10 in) (Fechhelm et al. 1999; CSA, 2004b) up to 45 cm (18 in) near a well measured in one study (CSA, 2006).

The primary concern related to muds and cuttings discharges is that of burial. Sedimentation originating from drilling fluids and cuttings discharges could smother and kill nonmotile deepwater reef organisms if allowed in the near vicinity. Those organisms having enough relief to extend above the sediment accumulation may be resistant to smothering. Carbonate outcrops and deepwater coral communities, such as the deepwater coral habitat first reported by Moore and Bullis (1960) and later by Schroeder (2002), are considered to be most at risk from oil and gas operations if not mitigated. Because deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover. Burial of previously exposed hard substrate would prevent future recolonization until some event that excavated the substrate again. However, in some cases *Lophelia* does form structures with some relief that would be more resistant to any conceivable thickness of drill cuttings.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

The potential impacts of accumulated drilling muds and cuttings are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive seafloor habitats are avoided. With the application of NTL 2009-G40, it is expected that no deepwater coral communities would be located closer than 610 m (2,000 ft) from the surface location of any muds and cuttings discharges.

Proposed Action Analysis

The routine activities associated with a CPA proposed action that would impact deepwater live-bottom communities would come from bottom-disturbing activities associated with anchoring, structure emplacement, pipelaying, and structure removal. These activities cause localized bottom disturbances and disruption of benthic communities in the localized areas. Routine discharge of drill cuttings with associated muds can also affect the seafloor. Deepwater live-bottom communities may be found in the CPA subareas that include water depths ≥300 m (984 ft), i.e., Offshore Subareas C200-800, C800-1600, C1600-2400, and C>2400 m (**Figure 3-1**). The levels of projected activity in these subareas as a result of a CPA proposed action are shown in **Tables 3-3 and 3-6**. A CPA proposed action is expected to result in the following for the relevant subareas: 82-162 exploration wells, 105-207 development wells, and 4-7 production structures. The BOEM's OCS Program's activities in the CPA are expected to result in the following for the years 2012-2051: 2,670-3,790 exploration wells, 3,300-4,680 development wells, and 100-120 production structures. Production structures would range from small subsea developments to large developments involving floating, fixed, or subsea structures.

The practice of discharging muds and cuttings at the sea surface at deepwater sites spreads the sediment across broad areas of the seafloor. The result of this dispersion is that seafloor habitats receive little additional sedimentation from drilling discharges in areas where it settles to the seafloor. Small amounts of sedimentation are normal for these environments. In situations where the substantial burial of typical, soft-bottom benthic infaunal communities occurred (adjacent to a drill site), recolonization by populations from neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms.

The NTL 2009-G40 describes BOEM's policy to search for and avoid deepwater coral communities or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The policies clarified in the NTL guidelines are exercised on all leases and applied as required mitigation measures to protect the habitats. Under the provisions described in the Bureau of Safety and Environmental Enforcement's NTL's, lessees operating in water depths >300 m (984 ft) are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support sensitive nonchemosynthetic communities. If BOEM's review identifies potential deepwater live-bottom habitats, the lessee must either move the operation to avoid the potential communities or provide photodocumentation illustrating the absence of sensitive benthic communities.

The impacts of pipeline contact on soft bottoms would be minimal because pipeline burial is not required in water depths >61 m (200 ft). Hard-bottom areas would be avoided for the same reasons described above.

Impacts from bottom-disturbing activities directly on deepwater coral communities are expected to be extremely rare because of the application of required protective measures as described by NTL 2009-G40. Should impacts occur, it could result in recovery times in the order of decades or more, with the possibility of the community never recovering (Food and Agriculture Organization of the United Nations, 2008; Jones, 1992; Probert et al., 1997). The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring avoidance of potential deepwater live bottoms identified on required geophysical survey records or by requiring photodocumentation to establish the absence of the communities prior to approval of the structure or pipeline emplacement.

Summary and Conclusion

Deepwater nonchemosynthetic communities are susceptible to physical impacts from anchoring, structure emplacement, pipeline installation, structure removal, and drilling discharges. Some impact to soft-bottom benthic communities from drilling and production activities would occur as a result of physical impacts and drilling discharges regardless of their locations. However, even in situations where the substantial burial of typical, soft-bottom benthic infaunal communities occurred, recolonization of populations from widespread neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms.

If a sensitive live-bottom community is subjected to direct impacts by bottom-disturbing activities, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. Should this occur, it could result in recovery times in the order of decades or more, with the possibility of the community never recovering (Food and Agriculture Organization of the United Nations, 2008; Jones, 1992; Probert et al., 1997).

Routine activities associated with a CPA proposed action are not expected to cause damage to the ecological function or biological productivity of sensitive deepwater live-bottom communities (deep coral reefs) due to the consistent application of BOEM's protection policies as described in NTL 2009-G40. Information included in required hazards surveys for oil and gas activities depicts areas that could potentially harbor nonchemosynthetic communities. This allows BOEM to require avoidance of any areas that are conducive to the growth of sensitive hard-bottom habitats. The same geophysical conditions associated with the potential presence of chemosynthetic communities also results in the potential occurrence of hard carbonate substrate and nonchemosynthetic communities. Because of the NTL 2009-G40 guidelines, these communities are generally avoided in exploration and development planning.

Impacts on sensitive deepwater communities from routine activities associated with a CPA proposed action would be minimal to none.

4.2.1.10.3. Impacts of Accidental Events

Background/Introduction

Accidental events that could impact nonchemosynthetic deepwater benthic communities are primarily limited to seafloor blowouts. A blowout at the seafloor could create a crater and could resuspend and disperse large quantities of bottom sediments within a 300-m (984-ft) radius from the blowout site. This would destroy any organisms located within that distance by burial or modification of narrow habitat quality requirements. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms (e.g. brittle stars, sea pens, and crabs) would not result in a major impact to the deepwater benthos ecosystem as a whole or even in relation to a small area of the seabed within a lease block. The application of avoidance criteria for deepwater coral communities described in NTL 2009-G40 precludes the placement of a well within 610 m (2,000 ft) of any suspected site of a deepwater coral community, therefore distancing the community from sedimentation resulting from a possible blowout.

All known reserves in the Gulf of Mexico have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. As discussed in **Chapter 3.2.1.5.4**, oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column and surface almost directly over the source location, thus not impacting sensitive deepwater communities. Therefore, the oil is expected to rise to the sea surface under natural conditions. This behavior is modified when dispersants are applied to the oil on the sea surface or at depth, causing the oil to mix with water. Some oil can also be broken into tiny droplets that disperse with the water currents when the oil is ejected under high pressure. The dispersed oil then begins to biodegrade and may flocculate with particulate matter in the water column, promoting sinking of the particles. Oil plumes that contact the seafloor before degrading could potentially affect sensitive benthic communities if they happen to encounter such a habitat in a localized area. The potential for weathered components from a surface slick, not treated with dispersants, to reach a deepwater community in any measurable volume would be very small.

Oil and chemical spills that originate at the sea surface are not considered to be a potential source of measurable impacts on deepwater live-bottom communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink, and the risk of weathered components of a surface slick reaching the benthos in any measurable concentration would be very small. Surface oil also could not physically mix to depths of deepwater communities under natural conditions (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002).

Although deepwater coral and other live-bottom communities often live in close association with hydrocarbon seeps (since the carbonate substrate is precipitated by chemosynthetic communities), this does not mean they are necessarily tolerant to the effects of oil contamination. Natural seepage is very constant and at very low rates as compared with the potential volume of oil released from a blowout or pipeline rupture. In addition, live-bottom organisms, such as *Lophelia pertusa*, inhabit areas around the perimeter of seeps and sites where hydrocarbon seepage has reduced its flow or stopped. Typical Gulf of Mexico oil is light and floats rapidly to the surface, rather than being carried horizontally across benthic communities by water currents (Johansen et al., 2001; MacDonald et al., 1995; Trudel et al., 2001).

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be relatively rare. Typically, deepwater coral habitats form on shelf breaks or topographic highs in the Gulf of Mexico near natural hydrocarbon seeps. The topographic highs are often associated with authigenic carbonate, which is a byproduct of microbial methane oxidation and sulfate reduction that occurs at hydrocarbon seep sites (CSA, 2007). Any hard substrate communities located in deep water would be particularly sensitive to impacts. Impacts to these sensitive habitats could permanently prevent recolonization by similar organisms requiring hard substrate. Adherence to the guidance provided in NTL 2009-G40 should prevent all but minor impacts to hard-bottom communities located the prescribed distance of more than 610 m (2,000 ft) from a well site. Under the current review procedures, carbonate outcrops (high reflectivity surface anomalies on seismic survey data) are targeted as one possible indication that sensitive hard-bottom communities are present. Any unique nonchemosynthetic communities that may be associated with carbonate outcrops or other topographical features would be avoided via this review, along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a potential geological hazard for any well sites. Any proposed impacting activity in water depths >300 m (984 ft) would automatically trigger the NTL 2009-G40 evaluation described above.

Proposed Action Analysis

A blowout at the seafloor could create a crater and could resuspend and disperse large quantities of bottom sediments within a 300-m (984-ft) radius from the blowout site. Resuspended sediments from a blowout would have minimal impacts on the full spectrum of soft-bottom community animals, including the possible mortality of a few megafauna specimens such as crab or shrimp. The application of avoidance criteria for sensitive deepwater live-bottom communities described in detail in NTL 2009-G40 should preclude a blowout by maintaining a minimum distance of more than 609 m (2,000 ft) from a well site, which is beyond the distance of expected benthic disturbance. Any sediment that may reach deepwater coral communities by traveling with currents would be physically dispersed and in low concentrations by the time it reached the communities.

The risk of various sizes of oil spills occurring in the CPA as a result of a CPA proposed action is presented in **Table 3-12**. The possibility of a spill >1,000 bbl in the CPA is estimated to be up to one spill during the 40-year period (2012-2051). The possibility of oil from a surface spill reaching depths of 300 m (984 ft) or greater in any measurable concentration is very small. Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10 m (33 ft). Modeling studies have shown oil could mix to 20 m (66 ft) in the water column (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). The results of field measurements and modeling exercises indicate that oil cannot physically mix under natural conditions to the depth of deepwater seafloor communities, which should protect them from surface oil.

A catastrophic spill, like the DWH event, could affect nonchemosynthetic community habitat if oil is ejected into deep water under high pressure, resulting in vigorous turbulence and the formation of microdroplets or if dispersants are applied at depth (**Appendix B**). The dispersed oil would be suspended in the water column and travel with currents. The use of dispersant increases oil concentrations in the water column, ultimately leading to precipitation on the seafloor in some form (Whittle et al., 1982; ITOPF, 2002). Lubchenco et al. (2010) report that chemically dispersed surface oil from the DWH remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. This seems reasonable since dispersant usage reduces the oil's ability to adhere to particles in the water column, slowing its rate of precipitation to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997), and oil droplets remain neutrally buoyant in the water column, creating a subsurface plume of oil (Adcroft et al., 2010). Since oil plumes would be carried by underwater currents, the impacts would be distributed from the source toward the direction that the water currents travel. Oil exposed to dispersant chemicals also becomes more dispersed and less concentrated the longer it remains floating or suspended in the water column. Oil treated with dispersant at depth can mix with the water column and be carried by currents to contact deepwater live-bottoms. Oil plumes reaching nonchemosynthetic communities could cause oiling of organisms resulting in the death of entire populations on localized sensitive habitats. These potential impacts would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. Concentrations of dispersed and dissolved oil in the DWH subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010). Depending on how long it remains in the water column, oil may be thoroughly degraded by biological action before contact with the seafloor. Water currents can carry a plume to contact the seafloor directly but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston, 1995; ITOPF, 2002). Oil also would reach the seafloor through consumption by plankton, with excretion distributed over the seafloor (ITOPF, 2002). These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action that would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Habitats directly in the path of the oil plume when the oil contacts the seafloor would be affected, but most oil would reach the seafloor in a widely scattered and decayed state. In addition, sublethal effects are possible for communities that receive a lower level of impact. These effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, loss of tissue mass, and similar effects (Rogers, 1990; Jackson et al., 1989; Frithsen et al., 1985; Cohen et al., 1977; Loya, 1976a).

Summary and Conclusion

Deepwater live-bottom communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The guidance provided in NTL 2009-G40 and proposed stipulations included in lease sales greatly reduce the risk of these physical impacts. It clarifies the requirement to avoid potential chemosynthetic communities identified on the required geophysical survey records or photodocumentation to establish the absence of potential hard-bottom communities prior to approval of the structure emplacement. Substantial impacts on these communities could permanently prevent reestablishment, particularly if hard substrate required for recolonization is buried by resuspended sediments from a blowout.

Accidental events resulting from a CPA proposed action are expected to cause little damage to the ecological function or biological productivity of widespread, typical, soft-bottom benthic communities. Some localized impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments. However, even in situations where the substantial burial of typical soft benthic communities occurred, recolonization by populations from neighboring substrate would be expected over a relatively short period for all size ranges of organisms; this can be in a matter of hours to days for bacteria and about 1-2 years for most all macrofauna species.

Impacts to deepwater coral habitats and other potential hard-bottom communities would likely be avoided as a consequence of the application of the policies described in NTL 2009-G40. The rare, widely scattered, high-density nonchemosynthetic communities located at more than 610 m (2,000 ft) away from a blowout could experience minor impacts from resuspended sediments that travel with currents, although the sediment concentration would be diluted with distance from the well. If dispersants are applied to an oil spill or if oil is ejected into deep water under high pressure (resulting in vigorous turbulence and the formation of micro-droplets), oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor where it may impact patches of sensitive deepwater community habitat in its path. As with sediments the farther the dispersed oil travels, the more diluted it will become as it mixes with surrounding water. These potential impacts would be localized due to the directional movement of oil plumes by the water currents because the sensitive habitats have a scattered and patchy distribution, because the sediments and oil disperse with distance, and because bacteria degrade the oil over time (and distance).

Accidental impacts associated with a CPA proposed action would typically result in only minimal impacts to nonchemosynthetic communities with adherence to the guidelines described in NTL 2009-G40. One exception would be in the case of a catastrophic spill combined with the application of dispersant, producing the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor (**Appendix B**). If such an event were to occur, it could take hundreds of years to reestablish the chemosynthetic community in that location. The possible impacts, however, would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect. Periods as long as hundreds of years are required to reestablish a chemosynthetic seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins.

4.2.1.10.4. Cumulative Impacts

Background/Introduction

Cumulative factors considered to impact the deepwater benthic communities (> 300 m; 984 ft) of the Gulf of Mexico include both oil- and gas-related and non-oil- and non-gas-related activities. The latter type of impacting factors includes activities such as fishing and trawling at a relatively small scale, and large-scale factors such as storm impacts and climate change. There are essentially only three fish (or "shellfish") species considered important to deepwater commercial bottom fisheries—the yellowedge grouper, tilefish, and royal red shrimp.

Yellowedge grouper habitat extends to about 275 m (902 ft). Bottom longlining for tilefish could potentially result in cumulative impact to deepwater communities as their habitat in the GOM extends to 540 m (1,772 ft) (FishBase, 2006). If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. De Forges et al. (2000) report threats to deepwater biological communities by fishing activity off New Zealand. In the 1980's when the orange roughy fishery exploded off New Zealand, catches from aggregations around deep-sea seamounts sometimes retrieved 60 tons of fish from a 20-minute trawl. After just 10 years, the fishery collapsed to less than 20 percent of the preexploited abundance. Species similar to the targeted species in Australia and New Zealand (e.g., the orange roughy [genus *Hoplostethus*]), do occur in the GOM; however, they are not abundant and are smaller in size. There is no information that this group of deep-sea fish has been exploited in the GOM. This is very fortunate because of the extensive destruction that would be caused to associated deepwater hard bottoms associated with the *Hoplostethus*' preferred habitat. In the GOM, this is most always authigenic carbonate and likely also associated with chemosynthetic communities or deepwater coral communities.

The royal red shrimp is fished in some areas of the Gulf. Its depth range spans 180-730 m (591-2,395 ft), but most are obtained from depths of 250-475 m (820-1,558 ft) in the northeastern part of the Gulf of Mexico (GMFMC, 2004b). This species is obtained from trawling using traditional but modified shrimp trawls. The use of traps for royal red shrimp was prohibited in Amendment 11 of the Shrimp Fishery Management Plan (GMFMC, 2006a). If trawling occurred in sensitive areas of deepwater habitats, extensive damage to those communities could occur, but the areas where royal red shrimp are obtained are not known for hard-bottom communities, and the shrimp prefer soft bottom composed of sand, clay, or mud (CSA, 2002). In addition, trawls used in the GOM are not the massive roller trawl types; royal red fishermen purposely avoid deepwater reef areas. Unlike other areas in the Atlantic and in Europe, bottom fishing and trawling efforts in the deeper water of the CPA are currently minimal, and impacts to deepwater benthic communities are negligible.

Other regional non-oil- and non-gas-related sources of cumulative impact to deepwater benthic communities would be possible, but they are considered unlikely to occur. Essentially no anchoring from non-OCS-related activities occurs at the deeper water depths considered for these resources (>300 m; 984 ft). Some impacts are highly unlikely yet not impossible, such as the sinking of a ship or barge resulting in collision or contaminant release directly on top of a sensitive, high-density nonchemosynthetic community.

The greatest potential for cumulative adverse impacts to occur to the deepwater benthic communities would come from those OCS-related, bottom-disturbing activities associated with pipeline and platform emplacement (including templates and subsea completions), associated anchoring activities, discharges of muds and cuttings, and seafloor blowout accidents.

As exploration and development continue on the Federal OCS, activities have moved farther into the deeper water areas of the Gulf of Mexico. With this trend comes the certainty that increased development would occur on discoveries throughout the entire depth range of the CPA; these activities would be accompanied by limited unavoidable impacts to the soft-bottom deepwater benthos from bottom disturbances and disruption of the seafloor from associated activities. The extent of these disturbances would be determined by the intensity of development in these deepwater regions, the types of structures and mooring systems used, and the effective application of the avoidance criteria as described in NTL 2009-G40 (USDOI, MMS, 2009b). Activity levels for the cumulative scenario in the CPA for the years 2012-2051 are shown in **Tables 3-3 and 3-6**. Deepwater nonchemosynthetic communities occur in waters ≥300 m (984 ft), which would include the CPA deepwater offshore Subareas C200-800, C800-1600, C1600-2400, and C>2400 (**Figure 3-1**). A CPA proposed action is estimated to result in 82-162 exploration wells, 105-207 development wells, and 4-7 production structures in these subareas. For all CPA proposed actions in this Five-Year Program, there are currently an estimated 2,670-3,790 exploration wells, 3,300-4,680 development wells, and 100-120 production structures to be installed by the end of the 40-year analysis period.

Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths >300 m (984 ft), as indicated in a major Agency-funded deepwater effects study completed in 2006, *Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico* (CSA, 2006). This project included determinations of the extent of muds and cuttings accumulations resulting from both exploratory and development drilling at three sites in approximately 1,000 m (3,281 ft) of water. Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within the 500-m (1,640-ft) radius of what was termed near-field stations. Generally, areas mapped as drilling muds were identified within about 100 m (328 ft) of well sites. Areas mapped as cuttings typically extended several hundred meters from well sites. Potential local cumulative impacts could result from accumulations of muds and cuttings resulting from consistent hydrographic conditions and drilling of multiple wells from the same location causing concentrations of material in a single direction or "splay." It is not expected that detectable levels of muds and cuttings discharges from separate developments or from adjacent lease blocks would act as a cumulative impact to deepwater benthic communities. The physical separation of well sites, great water depths, and adherence to the policies described in NTL 2009-G40, which precludes well development within 610 m (2,000 ft) of any suspected site of a deepwater benthic community, prevent separate activities from having overlapping effects.

The majority of deepwater communities are of low density and are widespread throughout the deepwater areas of the Gulf. Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The frequency of such impact is expected to be low. Physical disturbance to a small area would not result in a major impact to the ecosystem. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density communities are widely distributed but few in number and limited in size. They have a high standing biomass and productivity. High-density nonchemosynthetic communities would be largely protected by NTL 2009-G40, which serves to prevent impacts by requiring avoidance of potential deepwater benthic communities identified by association with geophysical characteristics or by requiring photodocumentation to establish the absence of deepwater benthic communities prior to approval of the structure or anchor placements.

Numerous new deepwater communities were recently discovered and explored using the submersible *Alvin* in 2006 and with the remotely operated vehicle *Jason II* in 2007 as part of a new Agency-funded study (Brooks et al., 2009). These new communities were targeted using the same procedures integral to the biological review process. The BOEM policies described in NTL 2009-G40 require that target areas of potential communities be avoided by impacting oil and gas activities. There is no reason to expect an increased vulnerability of these deep communities to cumulative impacts.

Small impacts are expected to occur infrequently, but the impacts from bottom-disturbing activities, if they occur, could be quite severe to the immediate area affected. If it occurred, the disturbance to well-developed, deepwater coral habitats (e.g., *Lophelia*) could lead to the destruction of a community from which recovery would occur only over long intervals. Other possible sublethal effects could include incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the immediate area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events. Subsea structure removals are not expected in water depths >800 m (2,625 ft), in accordance with 30 CFR 250. The distance of separation required by adherence to the guidelines described in NTL 2009-G40 would protect nonchemosynthetic communities from sedimentation effects of deepwater blowouts.

The use of dispersants on surface oil is not anticipated to affect seafloor communities in deep water. It is reported that chemically dispersed surface oil from the DWH event remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded (Lubchenco et al., 2010). Data from other studies on dispersant usage on surface plumes indicate that a majority of the dispersed oil remained in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Therefore, oil spills on the sea surface are expected to have little-to-no effect on deepwater benthic communities.

However, subsea oil plumes resulting from a seafloor blowout could affect sensitive deepwater communities. This could happen if oil is ejected into deep water under high pressure, resulting in vigorous turbulence and the formation of micro-droplets, or it is especially true if dispersants are applied at depth. A recent report documents damage to a deepwater coral community in an area that oil plume models predicted as the direction of travel for subsea oil plumes from the DWH event. Results are still pending but it appears that a coral community about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged, possibly the result of oil impacts (USDOI, BOEMRE, 2010j). Such blowouts are rare and may not release catastrophic quantities of oil. Oil that is released underwater would normally rise rapidly to the sea surface. However, if oil is ejected into deep water under high pressure, a plume of micro-droplets of oil can form. Treatment of the oil with dispersants at depth would also form a plume of oil that would be carried in whatever direction the water currents flow.

This directional flow could only affect seafloor habitats that are downstream from the source. Though the oil plume could be carried into direct contact with the seafloor at some distance from the source, a more likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; ITOPF, 2002). Oil would also reach the seafloor through consumption by plankton, with excretion distributed over the seafloor (ITOPF, 2002). Dispersant reduces the oil's ability to adhere to particles in the water column, slowing its rate of precipitation to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997), and oil droplets remain neutrally buoyant in the water column, creating a subsurface plume of oil (Adcroft et al., 2010). These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action that would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Sensitive deepwater communities appear to be widely scattered and not as rare as previously expected. Recent BOEM analyses of seafloor remote-sensing data indicate over 16,000 locations in the deep GOM that represent potential hard-bottom habitats (Shedd et al., 2011). While it is likely that any subsea oil plume traveling more than a few miles on the deep seafloor would cross at least one of these potential habitats, the plume may not contact the seafloor at that point. If the plume did contact the seafloor, it would result in a localized effect that is not expected to alter the wider population of the GOM.

In cases where high-density communities are subjected to greatly dispersed discharges or suspended sediments, the impacts are most likely to be sublethal in nature and limited in areal extent. The impacts to ecological function of high-density communities would be minor; minor impacts to ecological relationships with the surrounding benthos would also be likely.

Because of the great water depths, treated sanitary wastes and produced waters are not expected to have any adverse cumulative impacts to any deepwater benthic communities. These effluents would undergo a great deal of dilution and dispersion before reaching the bottom (if ever).

Oil and chemical spills on the sea surface (potentially from non-OCS-related activities) are not considered to be a potential source of measurable impacts on any deepwater communities because of water depth. Oil spills from the surface would tend to float. Oil discharges at depth or on the bottom would tend to rise in the water column and similarly not impact the benthos unless dispersants are applied at depth.

Although deepwater coral and other live-bottom communities often live in close association with hydrocarbon seeps (since the carbonate substrate is precipitated by chemosynthetic communities), this does not mean they are necessarily tolerant to the effects of oil contamination. Natural seepage is very constant and at very low rates as compared with the potential volume of oil released from a blowout or pipeline rupture. In addition, live-bottom organisms, such as *Lophelia pertusa*, inhabit areas around the perimeter of seeps and sites where hydrocarbon seepage has reduced its flow or stopped. Typical Gulf of Mexico oil is light and floats rapidly to the surface, rather than being carried horizontally across benthic communities by water currents (Johansen et al., 2001; MacDonald et al., 1995; Trudel et al., 2001).

Deepwater coral and other hard-bottom communities not associated with chemosynthetic communities are also expected to be protected from cumulative impacts by general adherence to requirements described in NTL 2009-G40 and the shallow hazards NTL 2008-G05 due to the avoidance of areas represented as hard bottom on surface anomaly maps derived from seismic records (USDOI, MMS, 2008c and 2009b). The deepwater coral communities would be protected because, typically, deepwater coral habitats form on shelf breaks or topographic highs in the Gulf of Mexico near natural hydrocarbon seeps. The topographic highs are often associated with authigenic carbonate, which is a byproduct of microbial methane oxidation and sulfate reduction that occurs at hydrocarbon seep sites (CSA, 2007). Any unique nonchemosynthetic communities that may be associated with carbonate outcrops or other topographical features would be avoided via biological reviews that are performed on all deepwater plans (exploration and production) and pipeline applications. These reviews include an analysis of maps and the avoidance of hard-bottom areas that are important indicators for the potential presence of nonchemosynthetic communities.

Summary and Conclusion

Cumulative impacts to deepwater communities in the Gulf of Mexico from sources other than OCS activities are considered negligible. The most serious, impact-producing factor threatening nonchemosynthetic communities is physical disturbance of the seafloor, which could destroy the organisms of these communities. Such disturbance would most likely come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to nonchemosynthetic communities, but substantial accumulations could result in more serious impacts. Seafloor disturbance is considered to be a threat only to the high-density communities; widely distributed low-density communities would not be at risk. Possible catastrophic oil spills due to seafloor blowouts have the potential to devastate localized deepwater benthic habitats. However, these events are rare and would only affect a small portion of the sensitive benthic habitat in the GOM. Recent analyses reveal over 15,000 possible hard-bottom locations across the deepwater GOM. However, because the guidance provided in NTL 2009-G40 describes required surveys and avoidance prior to drilling or pipeline installation, the risk would be greatly reduced. New studies have refined predictive information and confirmed the effectiveness of these provisions throughout all depth ranges of the Gulf of Mexico (Brooks et al., 2009). With the dramatic success of this project, confidence is increasing regarding the use of geophysical signatures for the prediction of nonchemosynthetic communities.

Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths in these areas (>300 m; 984 ft) and the low density of potentially commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes. Regionwide and even global impacts from CO_2 build-up and proposed methods to sequester carbon in the deep sea (e.g., ocean fertilization) are not expected to have major impacts to deepwater habitats in the near future. More distant scenarios could include severe impacts.

The proposed activities in the CPA considered under the cumulative scenario are not expected to cause damage to the ecological function or biological productivity of widespread, low-density deepwater communities. The rarer, widely scattered, high-density communities could experience isolated minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years, but even minor impacts are not expected. Major impacts to localized benthic habitat are possible in the event of a catastrophic blowout on the seafloor, particularly when chemical dispersants are applied to oil releases at depth. If physical disturbance (such as anchor damage) or extensive burial by muds and cuttings were to occur to high-density communities, impacts could be severe, with recovery time as long as 200 years for mature communities. There is evidence that substantial impacts on these communities could permanently prevent reestablishment. Other sublethal impacts include possible incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

The cumulative impacts on nonchemosynthetic benthic communities are expected to cause little damage to the ecological function or biological productivity of the expected typical communities existing on sand/silt/clay bottoms of the deep GOM. Large motile animals would tend to move, and recolonization of populations from neighboring substrates would be expected in any areas impacted by burial. The cumulative impacts on deepwater coral or other high-density, hard-bottom communities are expected to be negligible and to cause little damage to ecological function or biological productivity.

Although OCS activities are the primary impact-producing factors for these communities, the incremental contribution of a CPA proposed action to cumulative impacts is expected to be minimal. The possible impacts to these communities are decreased through BOEM's biological review process and the policies described in NTL 2009-G40, which physically distances petroleum-producing activities from sensitive deepwater benthic communities. The incremental contribution of a CPA proposed action to cumulative impacts is expected to be slight and to result from the effects of the possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension or drill cutting discharges. Adverse impacts would be limited but not completely eliminated by adherence to guidelines in NTL 2009-G40.

4.2.1.11. Soft-Bottom Benthic Communities

4.2.1.11.1. Description of the Affected Environment

The seafloor on the continental shelf in the Gulf of Mexico consists primarily of muddy to sandy sediments. The eastern shelf is primarily sand extending out to 100-m (328-ft) water depth, while the central and western shelf is a mixture of sand, silt, and clay (Brooks and Darnell, 1991). Sediments near the shoreline of the Alabama coast consist of fine-grained, well-sorted sand and transition to clay and marl (Ellwood et al., 2006; Balsam and Beeson, 2003). Sediments offshore of Mississippi and Louisiana are primarily silt and clay of terrigenous origin (Ellwood et al., 2006; Balsam and Beeson, 2003).

Benthic organisms found on the seafloor include infauna (animals that live in the substrate, including mostly burrowing worms, crustaceans, and mollusks) and epifauna (animals that live on or are attached to the substrate; mostly crustaceans, as well as echinoderms, mollusks, hydroids, sponges, soft and hard corals, and demersal fishes). Infauna is comprised of meiofauna, small organisms (63-500 μ) that live among the grains of sediment; and macroinfauna, slightly larger organisms (>0.5 mm; 0.02 in) that live in the sediment (Dames & Moore, Inc., 1979). Shrimp and demersal fish are closely associated with the benthic community. The most abundant organisms on the continental shelf are the deposit-feeding polychaetes. The slope and deep sea consist of vast areas of primarily fine sediments that support benthic communities with lower densities and biomass but higher diversity than the continental shelf (Rowe and Kennicutt, 2001).

Environmental Influences on Benthic Community Structure

Substrate is the single most important factor in the distribution of benthic fauna (densities of infaunal organisms increase with sediment particle size), although temperature and salinity are also important in determining the extent of faunal distribution (Vittor, 2000; Byrnes et al., 1999; Harper, 1991; Dames & Moore, Inc., 1979; Parker et al., 1975; Barry A. Vittor & Associates Inc., 1985; Defenbaugh, 1976). Depth and distance from shore also influence the benthic faunal distribution (Harper, 1991; Dames & Moore, Inc., 1979; Defenbaugh, 1976; Parker et al., 1975). Lesser important factors include illumination, food availability, currents, tides, and wave shock. Experiments indicate that fluctuating physical factors have a greater influence in estuaries than farther offshore, where sediment type is the primary influencing factor (Flemer et al., 2002).

Substrate type, as the most important control upon benthic infaunal assemblages, has been emphasized by previous sampling efforts over broad areas of the northern Gulf of Mexico shelf. Studies of the infauna of the Mississippi, Alabama, and Florida (MAFLA) OCS by Dames & Moore, Inc. (1979) revealed that inner shelf benthic habitats of the northeastern Gulf of Mexico can be described primarily on the basis of sediment texture and water depth. Barry A. Vittor & Associates, Inc. (1985) and Vittor (2000) categorized the OCS of the northern Gulf of Mexico based on sediment types and species associated with those habitats.

Infaunal assemblages are comprised of species adapted to particular sedimentary habitats through differences in behavioral, morphological, physiological, and reproductive characteristics. Feeding is one of the behavioral aspects most closely related to sedimentary habitat (Rhoads, 1974). In general, habitats with coarse sediment and high water current velocities, where organic particles are maintained in suspension in the water column, favor the occurrence of suspension-feeding taxa that strain food particles from the water column. Coarse sediments also facilitate the feeding of carnivorous taxa that consume organisms occupying interstitial habitats (Fauchald and Jumars, 1979). At the other extreme, habitats with fine-textured sediments and little or no current are characterized by the deposition and accumulation of organic material, thereby favoring the occurrence of surface and subsurface deposit-feeding taxa. In between these habitat extremes are a variety of habitat types that differ with respect to various combinations of sedimentary regime, depth, and hydrological factors, with each habitat type facilitating the existence of particular infaunal assemblages (Barry A. Vittor & Associates, Inc., 1985). An east-to-west transition of sedimentary regimes, from predominantly sands along the west Florida shelf to silts and clays along the Louisiana shelf, was evident during previous regional studies. Infaunal assemblages varied along this east-west gradient as well (Barry A. Vittor & Associates, Inc., 1985).

Descriptions of Continental Shelf Soft-Bottom Benthic Communities

Vittor (2000) described the general community composition of the infaunal habitats on the OCS of the northern Gulf of Mexico. He described the communities primarily based on sediment type and distance from shore and grouped the inhabitants by feeding mode.

- Assemblage I consisted of sandy sediments (<5% silt/clay or gravel) spread along the entire continental shelf. Dominant filter feeders on the shelf were mollusks (*Astarte nana*, *Chione intapurpurea*, *Ervilia concentrica*, *Tellina aequistriata*). Deposit feeders included mollusks (*Caecum cooperi*, *Caecum imbricatum, Cadulus tetrodon*) and ostracods (*Rutiderma darbyi*). Carnivores included polychaetes (*Nephtys picta*, *Sigambra tentaculata*, *Synelims albini*) and mollusks (*Nassarius albus, Tectonatica pusilla*).
- Assemblage II consisted of silty sand and sandy silt on the inner shelf in less than 100 m (328 m) of water. These areas generally have greater than 5 percent or 10 percent silt and are affected by sediment transport from estuaries. Burrowing and surface deposit-feeding polychaete detritivores such as *Armandia maculata*, *Dispio uncinata*, *Magelona petiboneae*, *Paraprionospio pinnata*, and *Spiophanes bombyx* inhabit this habitat. Filter-feeding crustaceans (*Ampelisca agassizi*, *Branchiostoma* sp.) and polychaetes (*Diopatra cuprea*, *Owenia fusiformis*) are also abundant.
- Assemblage III is comprised of patchy coarse sand or gravel. Deposit feeders in this group include mollusks (*Caecum cooperi*), amphipods (*Metharpinia floridana*), tanaids (*Apseudes* sp.), and polychaetes (*Aonides paucibranchiata*, *Chone duneri*, and *Filograna implexa*). *Chloeia viridis*, *Eunice vittata*, *Nephtys picta*, and *Bhawania heteroseta* are resident carnivores.
- Assemblage IV is comprised of fine and silty sand habitats in >100 m (328 m) of water. The most abundant organisms are the burrowing and surface deposit feeders including polychaetes (*Ampharete acutifrons*, *Aricidea neosuecica*, *Armandia maculata*, *Laonice cirrata*, *Poecilochaetus johnsoni*) and mollusks (*Nuculana acuta*, *Yoldia liorhina*). Polychaete carnivores/omnivores also include *Goniada maculata*, *Paralacydonia paradoxa*, and *Synelmis albini*.

Vittor (2000) based his community assemblages on his previous (Barry A. Vittor & Associates, Inc., 1985) descriptions of the continental shelf habitats between Florida and Louisiana. Barry A. Vittor & Associates, Inc. (1985) recognized four depth-related benthic habitats for infaunal communities in the region of the northeastern Gulf of Mexico: shallow beach habitat; inner shelf habitat; intermediate shelf habitat; and outer shelf habitat. Each of these habitats was further divided into sediment type (mud, sandy mud, muddy sand, or sand). Infaunal assemblage associations were recognized with each combination of water depth and substratum type. Cluster analysis revealed that infaunal taxa were closely tied to sediment type and texture.

The benthic habitat descriptions were a result of compiled habitat data collected from several studies conducted in the Tuscaloosa Trend regional area from the Florida to Louisiana shelves. Barry A. Vittor & Associates (1985) noted that the sediment is sandier on the Florida shelf and transitions to terrigenous silts and clays on the southeast Louisiana shelf. Sediment also becomes finer in the offshore direction.

The following material describes the macroinfauna and macroepifauna communities to the east of the Mississippi River.

- Shallow Beach Habitat is located in 2-4 m (7-13 ft) of water and consists of well sorted sand and shell fragments. Temperature and salinity fluctuate and wave action is heavy. Dominant species include bivalves (*Donax* spp.), echinoderms (*Mellita quinquiesperforata*), and amphipods (*Protohaustorius* spp.).
- Inner Shelf Habitat is located in 4-20 m (13-66 ft) of water and is adjacent to barrier islands. Species in this area tolerate lower salinities resulting from Mississippi River freshwater input. Infaunal species that dominate in muddy (<20% sand) portions of this area include a hemichordate (*Balanoglossus aurantiacus*), a polychaete (*Paramphinome* sp.), and mollusks (*Utriculastra canaliculata*, *Nassarius acutus*). Epifaunal inhabitants include a sea pansy (*Renilla mulleri*), mollusks (*Nassarius acutus*, *Nuculana concentricia*), shrimp (*Farfantepenaeus aztecus*, *Litopenaeus setiferus*, *Rimapenaeus similis*), and crabs (*Portunus* spp., *Callinectes similis*). Echinoderms (*Hemipholis elongate, Micropholis atra*), mollusks (*Nuculana concentrica*), and crustacea (*Pinnixia pearsei*) are found in sandy mud habitats (20-50% sand). Infaunal species found in sandy (>90% sand) habitats include polychaetes indicative of offshore environments (*Nephtys picta*, *Dispio uncinata*, *Onuphis nebulosa*, *Magelona riojai*, *Aricidea wassi*, *Apoprionospio pygmaea*, *Brania wellfleetensis*), amphipods (*Acanthohaustorius* sp., *Protohaustorius* sp., *Lepidactylus* sp.), the cephalochordate (*Branchiostoma carribeum*), and the archiannelid (*Polygordius* sp.), which are common in tidal inlets. Epifaunal species in this habitat include a sea pansy (*Renilla mulleri*), baby's ear gastropod (*Sinum prospectivum*), bivalves (*Noetia ponderosa, Chione clenchi*), brown shrimp (*Farfantepenaeus aztecus*), purse crabs (*Persephone* spp.), shame-faced crabs (*Calappa sulcata*, *Hepatus epheliticus*), and echinoderms (*Hemipholis elongate*, *Mellita quinquiesperforata*). Transitional polychaete species that thrive in both environments include *Magelona phyllisae*, *Paraprionospio pinnata*, *Mediomastus californiensis*, *Sigambra tentaculata*, and *Spiophanes bombyx*.
- Intermediate Shelf Habitat is located in 20-60 m (66-197 ft) of water and is comprised of both sand and mud environments. Muddy sediments are dominated by polychaetes (*Cirrophorus lyriformis*, *Nephtys incise*, and *Notomastus daueri*). Organisms in the sandy areas include polychaetes (*Aricidea wassi*), amphipods (*Metharpinia floridana* and *Ampelisca agassizi*), and tanaids (*Kalliapseudes* sp.). Polychaetes found in both sandy and muddy environments include *Cossura soyeri*, *Nereis micromma*, *Sigambra tentaculata*, and *Aglaophamus verrilli*. Epifaunal species found on the Intermediate Shelf Habitat include gastropods (*Strombus* sp., *Murex* sp., *Busycon* sp., *Fasciolaria* sp.), bivalves (*Argopecten* sp., *Tellina* sp., *Pitar* sp.), shrimps (*Penaeus* sp., *Sicyonia* sp.), crabs (*Calappa* sp., *Portunnus* sp., *Anasimus* sp., *Libinia* sp., *Parthenope* sp.), echnioids (*Encope* sp., *Stylocidaris* sp.), and starfish (*Luidia* sp., *Astropecten* sp.).
- Outer Shelf Habitat is comprised of mud (<20% sand) with the infauna characterized by polychaetes (*Notomastus latriceus*, *Nereis grayi*, *Cirrophorus lyriformis*, *Nephtys incisa*, *Paraprionospio pinnata*, *Mediomastus califirniensis*). A variety of epifauna are found in this zone including gastropods (*Turritella exoleta*, *Polystira albida*), bivalves (*Anadara* spp., *Verticordia ornate*), crabs (*Munida* sp., *Raninoides* sp., *Myropsis* sp.), echinoids (*Echinocardium* sp., *Brissopsis* sp.), and starfish (*Astropecten* sp., *Cheiraster* sp.).

Researchers from Texas A&M University collected benthic infauna and epifauna between the Mississippi Delta and De Soto Canyon as part of the Mississippi-Alabama Continental Shelf Ecosystem Study. Polychaetes dominated the macroinfauna, comprising 58.3 percent of the specimens taken, followed by bivalves and amphipods, comprising 12.2 percent and 9.4 percent of the specimens collected

(Harper, 1991). The density of the infaunal species was related to the sediment type where the highest densities were found in coarse sediments and lowest densities were found in slit and clay. Organism diversity and abundance also decreased with depth. Of the epifaunal species collected, decapods (primarily shrimp) made up over 77 percent, echinoderms made up over 9 percent and mollusks made up over 7 percent of the specimens taken (Harper, 1991). The decapods showed seasonal migration where they moved inshore to the Louisiana marshes during the summer and offshore during the winter (Harper, 1991).

Infaunal surveys of sand resources identified off the coast of Alabama described seasonal variation in dominant species. Sandy habitats were dominated by the gastropods *Caecum pulchellum* and *Caecum cooperi* (Byrnes et al., 1999). These two species were dominant in samples collected in both May and December; however, May surveys also had high numbers of spionid polychaetes (*Paraprionospio pinnata* and *Spiophanes bombyx*), while December surveys had high numbers of the archiannelid *Polygordius*, the polychaete *Scoletoma verrilli*, and the amphipod *Eudevenopus hondurans* (Byrnes et al., 1999). Infaunal species richness was much higher in May than December, and assemblage was determined by grain size (Byrens et al., 1999), as reported by Harper (1991). Sandy sediments had high numbers of archiannelids (*Polygordius*), lancelet (*Brachiostoma*), and polychaete (*Spiophanes bombyx*), while finer sediments had greater numbers of the polychaetes *Mediomastus* and *Paraprionospio pinnata* (Byrnes at al., 1999).

Epifaunal invertebrates collected off the Alabama coast were dominated by the roughneck shrimp (*Trachypenaeus constrictus*), squid (*Loligo* sp.), striped sea star (*Luidia clathrata*), and rock shrimp (*Sicyonia* spp.) (Byrnes et al., 1999). May surveys were numerically dominated by striped sea star, squid, and roughneck shrimp, while December surveys were dominated by roughneck shrimp, squid, penaeid shrimp, and rock shrimp (Byrnes et al., 1999).

Dames & Moore, Inc. (1979) collected meiofaunal, macroinfaunal, and macroepifaunal samples along the Mississippi-Alabama-Florida OCS during a MAFLA baseline environmental survey. Although many samples were collected to the east of the CPA, some samples were collected in the CPA. Those samples collected outside of the area were composed of similar organisms due to similar benthic environmental conditions in the northern Gulf of Mexico, and they may be used in determining trends.

Nematodes and harpacticoid copepods are the most abundant meiofauna on the OCS of the northern Gulf of Mexico. Higher densities were recorded closer to shore, and they decreased with distance offshore. Densities tended to be highest in medium to fine sediments with a moderate to high carbonate composition (Dames & Moore, Inc., 1979). The macroinfauna were dominated by polychaetes. Macroinfauna also had the highest densities inshore and decreased offshore, and the greatest diversity occurred within 30-60 m (98-197 ft) of water. Density, however, decreased with decreasing grain size. Macroepifauna was dominated by crustaceans and mollusks, followed by echinoderms and coelenterates, and the macroepifauna followed the same density gradient offshore as the meiofauna and macroinfauna.

Non-OCS Oil and Gas Program Threats to Benthic Communities

The benthic communities are threatened by two natural environmental perturbations: hypoxic to anoxic bottom conditions on the Louisiana-Texas continental shelf and tropical storms. Hypoxic conditions occur annually with inconsistent intensities and ranges (Rabalais et al., 2002). On average, one tropical storm of varying intensity occurs on the Louisiana continental shelf every 4 years (Stone, 2001).

The Gulf of Mexico hypoxic zone is a band that stretches along the Louisiana-Texas shelf each summer where the dissolved oxygen concentrations are less than 2 ppm. It is one of the largest hypoxic areas in the world's coastal waters. **Chapters 4.2.1.2.1.1 and 4.2.1.2.2.1** provide a detailed description of the GOM hypoxic zone. The hypoxic zone is the result of excess nutrients, primarily nitrogen, in the water. More than half the nitrogen comes from nonpoint sources about the confluence of the Ohio and Mississippi Rivers. A large variability in river discharge exists from year to year (Nowlin et al., 1998). Measurements of suspended particulate matter in the area of a CPA proposed action have found concentrations from <1 to 10 mg/L. The rivers' effects on temperature and salinity have been detected as far west as Galveston (Murray and Donley, 1996). **Chapters 4.2.1.2.1.1 and 4.2.1.2.2.1** provide a detailed description of runoff impacts in the GOM.

Storms can physically affect shallow-bottom environments, causing an increase in sedimentation, a rapid change in salinity or dissolved oxygen levels, storm surge scouring, and remobilization of contaminants in the sediment (Engle et al., 2008). Storms have also been shown to uproot benthic organisms from the sediment and suspend them in the water column (Dobbs and Vozarik, 1983). Studies conducted in the coastal waters of Louisiana, Mississippi, and Alabama 2 months after the passing of Hurricane Katrina revealed a significant decrease in the number of species, species diversity, and species density (Engle et al., 2008). The opportunistic polychaetes *Mediomastus ambiseta* and *Paraprionospio pinnata* dominated benthic communities 2 months after the storm, and some other species were completely missing from the community (Engle et al., 2008). Evidence shows that communities are not completely restructured after a storm event, but there may be a dominance shift, at least temporarily (Dobbs and Vozarik, 1983).

The frequent disturbances on the inner shelf cause the infaunal community to be dynamic and unstable and to remain at an immature level of development, compared with a mature and stable community comprised of large, deep-dwelling, head-down deposit feeders. Transitional taxa are able to numerically dominate habitats that experience various perturbations, including siltation, low salinity, and low levels of dissolved oxygen (hypoxia) (Thistle, 1981; Rabalais et al., 2002). Recolonization of depurated areas by populations from unaffected neighboring soft-bottom substrate would be expected to occur within a relatively short period of time (Dubois et al., 2009; Thistle, 1981). Initial repopulation from nearby stocks may begin with subsequent recruitment or immigration events and may be predominantly comprised of pioneering species, such as tube-dwelling polychaetes or oligochaetes (Rhodes and Germano, 1982). Full recovery will follow as later stages of successional communities overtake the opportunistic species (Rhodes and Germano, 1982), but the time it takes to reach a climax community may vary depending on the species and degree of impact. This environmental unpredictability selects for opportunistic organisms that rapidly reach sexual maturity and produce large quantities of offspring repeatedly throughout the year. Species requiring an extended growth and development period or more constant environmental conditions may not survive to maturity. These environmental threats tend to produce communities with lower biodiversity and biomass since longer-lived species tend to be eliminated.

It is also important to note that the Gulf floor is influenced by many sources of anthropogenic pollution and natural oil seeps that contribute PAH's to the sediments (MacDonald, 2002). Benthic organisms experience low-level hydrocarbon exposure through all of these inputs. For example, PAH's have been detected in sediments throughout the Gulf seafloor; these are from natural seeps as well as other human inputs (OSAT, 2010). The PAH's were detected in 321 of the 388 samples collected from many different sources for the OSAT (2010) study.

Deepwater Horizon Event Impacts on Soft-Bottom Benthic Communities

The potential oiling footprint as reported through the National Oceanic and Atmospheric Administration's ERMA (posted on the GeoPlatform.gov website) indicated that oil was recorded in surface waters of the CPA (USDOC, NOAA, 2011b). Oiled surface water was observed from Lake Charles, Louisiana, to Panama City, Florida, although the oil was distributed in patches and ribbons rather than a continuous blanket of petroleum (USDOC, NOAA, 2011b). The oil also migrated over time and did not have continuous cover over the entire area for the duration of the spill (USDOC, NOAA, 2011b).

Water and sediment samples collected during and after the spill were analyzed as part of the OSAT (2010) report. A handful of samples collected off the Gulf Coast did reveal some PAH's as a result of the DWH event; however, very few of the total number of water or sediment samples collected revealed exceedances of USEPA aquatic life benchmarks (OSAT, 2010). There were 6 water samples out of 481 collected that exceeded the USEPA chronic toxicity benchmarks for PAH's in the offshore waters (>3 nmi [3.5 mi; 5.6 km] offshore to the 200-m [656–ft] bathymetric contour), all of which occurred within 1 m (3 ft) of the water surface (OSAT, 2010). There were 63 samples collected from deep water (>200-m; 656-ft depth) out of 3605 samples collected that exceeded the USEPA aquatic life benchmarks for PAH (OSAT, 2010). Exceedances occurred near the water surface or in the deepwater plume within 70 km (43 mi) of the well.

Oil detected in the subsurface plume was between 1,100 and 1,300 m (3,609 and 4,265 ft) deep and was moving southwest along those depth contours (OSAT, 2010). No sediment samples collected offshore (>3 nmi [3.5 mi; 5.6 km] offshore to the 200-m [656-ft] depth contour), and seven sediment samples collected in deep water (>200-m; 656-ft depth) exceeded the USEPA aquatic life benchmarks for PAH exposure (OSAT, 2010). All chronic aquatic life benchmark exceedances in the sediment occurred within 3 km (2 mi) of the well, and samples fell to background levels at a distance of 10 km (6 mi) from the well (OSAT, 2010). Refer to the "Sediment Water Interface Exposure" and "Sedimented Oil (Oil Adsorbed to Sediments)" discussions below for further details on sediment studies. Dispersants were also detected in waters off Louisiana, but they were below the USEPA benchmarks of chronic toxicity. No dispersants were detected in sediment on the Gulf floor (OSAT, 2010). Benthic communities in the CPA located within 70 km (43 mi) of the well, therefore, may have been impacted by PAH's in the water column or by sediment, as they are located within the radius of benchmark exceedances. However, the entire 70-km (43-mi) radius is not expected to be affected, as samples with exceedances were patchy and few.

It is important to note that the effects of oil exposure to soft-bottom benthos are anticipated to have only impacted a very small portion of the seafloor of the Gulf of Mexico. Although approximately 4.64 MMbbl of oil were released into the Gulf waters, not all of that oil reached the seafloor. Reports estimated that as of November 2010, 23-26 percent of the released oil remains in the environment as oil on or just below the water surface as a light sheen or tarballs, oil that was washed ashore or collected from the shore, and oil that is in the sediments (Lubchenco et al., 2010; Lehr et al., 2010). Currently, the bulk deposits of oil have been removed from beaches, and the remaining oil that reached shorelines has been buried (e.g., through wave action and hurricanes) and is weathering over time (OSAT-2, 2011). Oil that has been deposited on the floor of the Gulf has also weathered (OSAT, 2010). This residual oil has been degrading over time. The greatest concentrations are expected to be near the wellhead and to decrease with distance from the source. The modes of transport to the seafloor discussed below are anticipated to only deliver a small amount of oil to the seafloor, with decreasing concentrations away from the well.

The weathering process began as the oil traveled from the well to the sea surface or horizontally in the subsea plume. The parent oil became depleted in its lower molecular weight PAH (which are the most acutely toxic components), and the longer the oil spent in the water column or at the sea surface, the more diluted and weathered it became (Brown et al., 2010; Eisler, 1987; Lehr et al., 2010; OSAT-2, 2011). The greatest concentrations of oil that settled to the seafloor are expected to be near the wellhead and to decrease with distance from the source. The modes of transport to the seafloor discussed below are anticipated to only deliver a small amount of oil to the seafloor, with decreasing concentrations away from the well. Infaunal benthic organisms may have been exposed to hydrocarbons that settled to the seafloor on sediments and detrital material, epifaunal benthic organisms may have been exposed to oil in the subsea plume that traveled along depth contours, and mobile benthic organisms that use the water column for parts of their life cycle may have been exposed to hydrocarbons at the sea surface.

As discussed earlier, the majority of the seafloor of the Gulf of Mexico is covered in soft sediments. Oil released from the DWH event may have impacted some of the organisms that live on or in these sediments. Direct contact with high concentrations of oil may have resulted in acute toxicity to organisms close to the well, and lower concentration exposures may have resulted in sublethal impacts to individuals such as altered reproduction, growth, respiration, excretion, chemoreception, feeding, movement, stimulus response, and susceptibility to disease (Suchanek, 1993). These impacts may occur through exposure pathways at the sediment/water interface or in the sediment itself.

A majority of the impacts to soft-bottom benthic communities in the CPA would be a result of low-level or long-term exposure to dispersed sedimented oil. Impacts to benthic communities may include reduced recruitment success and shift in community dominance. The PAH's were detected in sediments throughout the Gulf seafloor, from both the Mississippi Canyon Block 252 oil and other undetermined sources, in 321 of the 388 samples collected for the OSAT (2010) study; however, the PAH concentrations were below the USEPA aquatic life benchmarks of concern. A relatively small portion of the entire CPA is anticipated to have been impacted by the DWH event, and discussions of possible impacts as a result of the spill are included in this section. There remains some incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on soft-bottom benthic communities. Much of this information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data that have been released, as described in this section, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives.

Sediment Water Interface Exposure

A portion of the oil that was released from the well rose to the sea surface, but because the oil was ejected under pressure, oil droplets become entrained deep in the water column. The upward movement of the oil was reduced because methane in the oil was dissolved at the high underwater pressures, reducing the oil's buoyancy (Adcroft et al., 2010). The large oil droplets rose to the sea surface, but the smaller droplets, formed by vigorous turbulence in the plume and the subsea injection of dispersants, remained neutrally buoyant in the water column, creating a subsurface plume of oil (Adcroft et al., 2010). Oil droplets <100 μm (0.0036 in) in diameter remained in the water column for several months (Joint Analysis Group, 2010a). Oil detected in the subsurface plume was between 1,100 and 1,300 m (3,609 and 4,265 ft) deep and was moving southwest along those depth contours (OSAT, 2010). Epibenthic organisms that protrude above the sediment or those that feed at the sediment water interface may have been exposed to oil droplets in the water column or at the seafloor/water interface near the subsea plume.

Concentrations of dispersed and dissolved oil in the subsea plume were reported to be in the parts-per-million range or less and decrease with distance from the wellhead (Lubchenco et al., 2010; Adcroft et al., 2010; Joint Analysis Group, 2010a). The hydrocarbon concentrations in the water column and subsea plume were close to, and below, the values reported by others for dispersed oil in the water column after oil spills. Oil concentrations ranged from <1 to 3 ppm at approximately 10 m (33 ft) below the sea surface (McAuliffe et al. 1981a; Lewis and Aurand, 1997). Although McAuliffe et al. (1981a) and Lewis and Aurand (1997) did not address subsea plumes, the oil concentrations in the subsea plume appear to be similar to the concentrations reported from surface use of dispersants (Lubchenco et al., 2010; Adcroft et al., 2010; Joint Analysis Group, 2010a).

The strata, which are 1,100-1,400 m (3,609-4,593 ft) below the sea surface where the subsea plume occurred, however, were places that scientists recorded visible impact to benthic organisms. A recent report documents damage to a deepwater (1,400 m; 4,593 ft) coral (gorgonian) community 11 km (7 mi) to the southwest of the well; the direction of travel of the subsea oil plume. Results are still pending but it appears that a coral community about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged and may have been the result of contact with the subsea oil plume (Fisher, 2010a; USDOI, BOEMRE, 2010j). **Chapter 4.2.1.10** for a detailed description of the affected deepwater coral community.

Although coral was damaged 11 km (7 mi) from the well, sediment cores collected from this location did not contain levels of oil that exceeded USEPA's aquatic life benchmarks (OSAT, 2010). Based on the samples collected by OSAT (2010) and USEPA's aquatic life benchmarks, infaunal benthic organisms should not have experienced fatality as the deepwater corals did. A probable explanation for the detrimental impacts to corals, in the absence of USEPA aquatic life benchmark exceedances in the sediment, is that the coral community forms structures that protrude up into the water column that would be affected by a passing oil plume in a way that a typical smooth soft bottom would not. Also, even though the sediment samples in the area did not exceed USEPA's aquatic life benchmarks, the corals were within a 70-km (43-mi) radius where water samples exceeded USEPA's aquatic life benchmarks (OSAT, 2010). Therefore, an oil plume would pass over smooth soft bottom, continuing the process of biodegradation in mid-water and continuing to be dispersed over a wide area, not affecting the organisms below the sediment surface. Dispersed oil, however, may come in contact with benthic organisms that move into the water column or at the sediment/water interface. Also, during the passage of an oil plume, benthic filter or suspension feeders have the ability to simply withdraw into the substrate until water quality improves, which corals cannot do.

Benthic organisms in the CPA, especially those emergent in the water column, more than 70 km (43 mi) from the well should not have been exposed to lethal concentrations of oil because oil in the plume was diluting with distance from the well, decreasing in concentration with time, and there were no exceedances of the USEPA aquatic life benchmarks for PAH's measured in the water column more than 70 km (43 mi) from the well (OSAT, 2010). Also, tiny droplets of oil dissolved in the water column as they rose to the sea surface due to the depth and pressure of their release (Lehr et al., 2010). The lower molecular weight aromatic compounds (those with the greatest toxicity) were the compounds that dissolved most readily, and dissolution continued with continued exposure to uncontaminated surrounding water (Lehr et al., 2010; Brown et al., 2010; Eisler, 1987). The dissolution of oil into surrounding water allowed for dilution that further decreased the probability that concentrated oil could impact organisms more than 70 km (43 mi) from the well.

Water Column Exposure

Several commercially important benthic organisms (crabs and shrimp, for example) utilize the water column for part of their life cycle and may have been exposed to petroleum hydrocarbons in the water. Since petroleum hydrocarbon concentrations were higher near the water surface and closer to the well, the greatest impact to any mobile benthic organisms would be at the water surface, with increasing exposure closer to the well. Organisms that are distanced from the well have a much reduced probability of contacting surface oil, but since currents can transport larvae great distances, there is a possibility that larvae in the water column may have been exposed to oil.

The larval zoea of blue crab develop in offshore waters during the spring and early summer where they are subject to distribution by currents before the megalopal stage moves into coastal habitat in late summer and early fall (Perry and McIlwain, 1986). Brown shrimp spawn offshore in waters between 18 and 137 m (59 and 450 ft) during two spawning peaks (September through November and April through May) in the northern GOM (Lassuy, 1983). Postlarval recruitment into estuaries may take several months (Lassuy, 1983). White shrimp spawn offshore from April to August, with peaks in June and July, and postlarvae move inshore to estuaries (Muncy, 1984). All three of these species spawned in offshore Gulf waters during the time of the oil spill and their larvae may have been exposed to hydrocarbons in the water column.

Newly recruited blue crabs and peneaid (white and brown) shrimp were collected from Alabama salt marshes after the spill and have shown to have declined in abundances as compared with the previous year (Moody et al., 2011). However, resident salt-marsh species also declined in abundance, although overall species diversity in the marsh did not decline, indicating a possible interannual variability in recruitment success of several species rather than oil toxicity to offshore spawners (Moody et al., 2011). Analysis of water and sediment samples are necessary to determine if there was an oil spill-related impact to reduced recruitment in 2010 (Moody et al., 2011). Another study reported blue crab megalope recruitment from nine estuary locations between Galveston, Texas, and Apalachicola, Florida (Grey et al., 2011a). Results indicated that the 2010 recruitment year did not appear to be substantially different from previous years; however, orange fatty droplets were observed inside the carapaces of some megalope and are under investigation (Grey et al., 2011a; Grey et al., 2011b).

There are some data available on hydrocarbons and dissolved oxygen levels in the water column during the DWH event (Chapter 4.1.1.2). Water samples collected by the R/V *Weatherbird* on May 23-26, 2010, located 40 nmi and 45 nmi (46 mi and 52 mi; 74 km and 83 km) northeast and 142 nmi (163 mi; 263 km) southeast of the DWH rig revealed that concentrations of total petroleum hydrocarbons in the water column were <0.5 ppm (Haddad and Murawski, 2010). The total petroleum hydrocarbons concentrations were generally higher near the water's surface and closer to the wellhead (Haddad and Murawski, 2010; Joint Analysis Group, 2010a). Any water samples that had PAH concentrations that exceeded USEPA aquatic life benchmarks occurred within 1 m (3 ft) of the water surface and within 70 km (43 mi) of the wellhead (OSAT, 2010).

The hydrocarbon concentrations measured in the water column after the DWH event were close to, and below, the values reported by others for dispersed oil in the water column after oil spills. McAuliffe et al. (1981a) reported dispersed oil concentrations between 1 and 3 ppm, 9 m (30 ft) below the sea surface, 1 hour after treatment with dispersant, and Lewis and Aurand (1997) reported dispersed oil concentrations <1 ppm, 10 m (33 ft) below the sea surface.

The available data suggest that, except for samples taken close to the well, the concentrations of oil in the water column were low and the oil was dispersed. These data suggest that benthic organisms in the CPA that were exposed to oil as a result of the DWH event were probably most affected close to the well and that the concentrations farther from the well were very low (in the part-per-million range or less), resulting in a much reduced impact. Even larvae exposed to hydrocarbons in the CPA, except for those close to the well, should have experienced low-level exposure.

Hypoxia from Oil Biodegradation

Reduced oxygen conditions, or hypoxia, caused by the presence of oil in the water column and resultant break down of petroleum hydrocarbons by bacteria was also a concern. Numerous stations were sampled throughout the Gulf of Mexico by several research vessels between May 8 and August 9, 2010.

Measured dissolved oxygen levels never reached hypoxic conditions (1.4 ml/L or 2 mg/L) and, in fact, were never below 2.5 ml/L at any station sampled (Joint Analysis Group, 2010a and 2010b).

A subsea hydrocarbon plume, which generally trended southwest from the release at the wellhead, was discovered during sampling events (Joint Analysis Group, 2010a; OSAT 2010). Dissolved oxygen anomalies were measured at 1,000-1,400 m (3,281-4,593 ft) below the sea surface, which corresponded to the depths that hydrocarbons from the DWH event were located (Joint Analysis Group, 2010b). Models indicated that hypoxic levels may be reached in the subsea plume when methane is oxidized (Adcroft et al., 2010). Field measurements indicated that these dissolved oxygen depressions, however, did not approach hypoxic levels as of August 9, 2010 (Joint Analysis Group, 2010b). The dissolved oxygen in the water column did not appear to be decreasing over time, indicating that the oil was mixing with the surrounding oxygen-rich water (Joint Analysis Group, 2010b).

Dissolved oxygen measurements taken at the seafloor between May 15 and May 25 were between 4.0 and 5.0 ml/L (Joint Analysis Group, 2010a). Dissolved oxygen was toward the lower end of the measurements south and southwest of the wellhead and was toward the higher end to the north and northwest of the wellhead (Joint Analysis Group, 2010a). Dissolved oxygen levels of this concentration are far above the hypoxic range (<1.4 ml/L) and are not anticipated to result in loss of the benthic population. **Chapters 4.2.1.2.1.1** and **4.2.1.2.2.1** provide a detailed description of water quality in the Gulf of Mexico following the DWH event.

A yearly hypoxic event on the continental shelf of the northern Gulf of Mexico off the Mississippi and Atchafalaya Rivers result in bottom oxygen levels dropping below 1.4 ml/L (2 mg/L) for prolonged periods during the spring through late summer (Rabalais et al., 2002a). This hypoxic event results in lower dissolved oxygen levels than what were measured in the water column and bottom waters as a result of the DWH event (Joint Analysis Group, 2010a and 2010b; Haddad and Murawski, 2010). In 2010, the "dead zone" was one of the largest measured, covering approximately 20,000 km^2 (7,722 mi^2) and affecting both Louisiana and Texas waters (LUMCON, 2011). The yearly hypoxia results in most of the benthic organisms leaving the area or dying; however, data indicates that the benthic colonies recolonize yearly after this event (Rabalais et al., 2002a; Diaz and Solow, 1999). This pattern of yearly disturbance and recruitment favors opportunistic species (for organisms that die as a result of the hypoxia), resulting in a community composition that does not reach its climax.

Based on the above water column and seafloor data, benthic communities would not have been lost due to hypoxia caused by the DWH event. Naturally occurring, yearly annual events cause lower dissolved oxygen levels than what were recorded as a result of the DWH event. The yearly hypoxic zone would likely have occurred during the DWH event and resulting spill, with its typical effects. However, if any organisms were lost due to reduced oxygen levels caused by natural occurrences or by biodegradation of oil in the environment, they should recolonize the area similarly to the yearly hypoxic event.

Sedimented Oil (Oil Adsorbed to Sediments)

Some of the smaller suspended oil droplets resulting from forceful injection at depth could have been carried to the seafloor as a result of oil droplets sedimenting to suspended particles in the water column. Some portion of the oil treated with dispersant, although having less affinity for adhering to suspended sediment, may still have settled to the seafloor before completely biodegrading. Oiled sediment that settled to the seafloor may affect the underlying organisms. It is not yet known how much oil sedimented to particles and settled to the seafloor. If large amounts of oil made its way to the seafloor, the underlying benthic communities may have been smothered by the particles or exposed to toxic hydrocarbons. The greatest concentration of sedimented oil occurred close to the well, and oil dispersed over wider areas with lower concentrations as it traveled farther from the source (Haddad and Murawski, 2010; Joint Analysis Group, 2010a; OSAT 2010).

There is very little data available on the impacts of the DWH event on benthic communities or benthic community structure on the seafloor of the Gulf of Mexico after this event. There are some data on the concentrations of hydrocarbons in sediments. The PAH's were detected in sediment on the Gulf floor in almost every sample collected by OSAT (2010) offshore of Louisiana to Florida; however, not all of the PAH's measured in sediment were a result of the DWH oil spill (OSAT, 2010). Only 7 samples of the 388 samples collected in the offshore zone (3 nmi [3.5 mi; 5.6 km] offshore to the 200-m [656–ft] depth contour) and deepwater (>200-m; 656-ft depth) were determined to have the Mississippi Canyon

Block 252 signature and exceeded the USEPA chronic aquatic life benchmark (OSAT, 2010). These samples were collected within 3 km (2 mi) of the well site. Sediment PAH concentrations reached background levels within 10 km (6 mi) from the well (OSAT, 2010). These data indicate that impacts to soft-bottom benthic communities in the CPA should generally occur within 3 km (2 mi) of the well, possibly out to 10 km (6 mi) in areas where PAH's were slightly elevated.

The preliminary results of one study reported that sediment toxicity was greater near the wellhead than at a distance (Arismendez et al., 2011a). Toxic effects were reported to benthic organisms in laboratory exposures using sediment collected out to 25 and 50 km (16 and 31 mi) to the southwest of the well site (the direction of the subsea plume flow) (Arismendez et al., 2011b). Concentrations of oil-contaminated sediment required to kill 50 percent of the test populations ranged from 575.8 to 94,699 mg/L, with the lower values occurring in sediments collected closer to the well (translating to higher toxicity) (Arismendez et al., 2011a). Another study, which looked at meiofauna collected throughout the GOM, from 2007 through 2010, from the Mexico border around to the tip of Florida, including areas affected by the oil spill, reported that meiofauna populations varied considerably within years (Romano and Landers, 2011). Variability from 2007 through 2010 was determined to be due to patchy distributions in meiofauna throughout the years rather than oil spill-related (Romano and Landers, 2011). The results of these two studies indicate that impacts to benthos were localized, and the populations throughout the Gulf are more likely impacted by recruitment variability than toxic exposure, especially at great distances from sources of contamination.

Also, some chemically dispersed surface oil may have reached the seafloor, but presumably in very low concentrations. It is reported that chemically dispersed surface oil from the DWH event remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded (Lubchenco et al., 2010). Data from other studies on dispersant usage on surface plumes indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing the ability of dispersed surface oil to adsorb to particles and travel to the seafloor (McAuliffe et al., 1981a). Any dispersed oil that reached the seafloor from the water's surface during this event would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a).

Oil dispersed in the subsurface plume may have also reached the seafloor. However, as with the surface dispersed oil, concentrations reaching the seafloor would be extremely low. Concentrations of dispersed and dissolved oil in the subsea plume were reported to be in the parts-per-million range or less and decrease with distance from the wellhead (Lubchenco et al., 2010; Adcroft et al., 2010; Joint Analysis Group, 2010a).

The presence of dispersants were detected in very few sediment samples (8 out of 775) collected from the seabed of the GOM between Louisiana and Florida nearshore (shoreline to 3 nmi [3.5 mi; 5.6 km] offshore), offshore (3 nmi [3.5 mi; 5.6 km] to 200-m [656-ft] depth contour), and in deep water (deeper than 200 m [656 ft]) after the DWH event (OSAT, 2010). Six of those samples were found in nearshore waters. Of those eight samples, there were no instances of dispersant levels in the sediment exceeding the USEPA established aquatic life benchmarks for PAH's (OSAT, 2010). Therefore, infaunal benthic organisms should not have experienced toxicity as a result of exposure to dispersants in the sediment.

Acute Toxicity and Recovery

The greatest threat to the benthic communities is anticipated to be the sedimented oil that may reach the seafloor. Because oil concentrations decreased in the water column away from the well, the highest sedimented oil concentrations were in areas closer to the well. Soft-bottom infaunal communities near the wellhead may have been negatively impacted by direct contact with sedimented oil and may experience sublethal (exposure) and/or lethal (smothering) effects, especially within 3 km (2 mi) of the well, where PAH concentrations exceeded the USEPA aquatic life benchmarks (OSAT, 2010).

Localized areas of lethal effects will be recolonized by populations from neighboring soft-bottom substrate once the oil in the sediment has been sufficiently reduced to support marine life (Sanders et al., 1980). Opportunistic species, such as tube-dwelling polychaetes or oligochaetes, would be the first to appear. These species would occur within the first recruitment cycle of the surrounding populations and from species immigrating from surrounding stocks (Rhodes and Germano, 1982). These pioneering species would maintain a stronghold in the area until community succession begins (Rhodes and

Germano, 1982; Sanders et al., 1980). Full recovery would follow as later stages of successional communities overtake the pioneering species (Rhodes and Germano, 1982). The time it takes to reach a climax community may vary depending on the species and degree of impact. Full benthic community recovery may take years to decades if the benthic habitat is heavily oiled (Gómez Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982).

One must be careful, however, in studying the impacts of the DWH event. One should not immediately designate benthic communities that contain pioneering species as areas that were defaunated as a result of the DWH event. Benthic populations in the Gulf of Mexico that experience yearly hypoxic events are perpetually in early successional stages (Gaston et al., 1998; Diaz and Solow, 1999). These communities are dominated by small, opportunistic, surface-feeding polychaetes and there is a lack of large, suspension-feeding bivalves (Gaston et al., 1998; Rabalais et al., 2002a).

However, one may be able to presume that the early successional stage of a large area of the northern Gulf of Mexico reveals its ability to quickly recover from stressful events, such as yearly hypoxia in areas, and therefore suggests that the benthic community may also rapidly return to its prior state if it was impacted by oil. Recovery after hypoxic events has been reported to begin within 6 months, and full recovery to the original community state has been seen in 1-2 years, depending on other environmental disturbances (Diaz and Solow, 1999; Harper et al., 1991). Similar recovery times would be expected for most communities exposed to sedimented oil unless the area is heavily oiled and, therefore, recovery could take much longer (Gómez Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982).

The areas that may be defaunated as a result of the DWH event are small compared with the area of the entire seafloor of the Gulf of Mexico. The greatest damage is anticipated to have occurred closest to the well where hydrocarbon readings were highest. Most of the seafloor is not anticipated to experience any impact from the event. The small footprint of impact was reported by OSAT 2010 where only 7 sediment samples of the 388 collected were determined to have the Mississippi Canyon Block 252 signature and exceed USEPA's chronic aquatic life benchmark (OSAT, 2010). These samples were collected within 3 km (2 mi) of the well site. Sediment PAH concentrations reached background levels within 10 km (6 mi) from the well (OSAT, 2010). Additionally, there were no instances of dispersant levels in the sediment exceeding USEPA's established aquatic life benchmarks for PAH's (OSAT, 2010). In areas farther from the well where low levels of oil could reach the seafloor, sublethal or immeasurable impacts may occur.

Sublethal Impacts

Research on oil spilled from the Chevron Main Pass Block 41C Platform into the Gulf of Mexico has indicated that oil in bottom sediments can weather rapidly, leaving only a small percentage of the oil in the sediments after a year (McAuliffe et al., 1975). Substantial weathering was noted 1 week and 1 month after the Chevron Main Pass spill, and the oil remained in the top 1.5 in (3.8 cm) of the sediment. Benthic community fluctuations could not be correlated to the oil in the sediment from this oil spill, and the numbers of brown and white shrimp and blue crabs in the area of the oil spill did not appear to decrease 3 months or 1 year after the spill (McAuliffe et al., 1975). Although the volume of the Chevron Main Pass spill was much less than the spill that resulted from the DWH event, it is probable that oil on the seafloor would behave the same way and weather similarly.

The *Ixtoc* oil spill in the Bay of Campeche, Gulf of Mexico, was much more on scale with the volume of oil as a result of the DWH spill that entered the Gulf of Mexico. The *Ixtoc* blowout flowed for 290 days and resulted in an estimated 120,000 metric tons of oil reaching the seafloor (Jernelöv and Lindén, 1981). Oil reached the seafloor in small droplets in the offshore waters, although some aggregates formed nearshore. The approximate concentration of oil on the seafloor was 1 g/m^2, which is not high enough to cause substantial damage to a benthic ecosystem (Jernelöv and Lindén, 1981). Surface sediment samples collected mid- and post-spill did not reveal any hydrocarbons from the *Ixtoc* spill; however, hydrocarbons from this source were identified on suspended sediment in the water column (ERCO, 1982). This data show that the oil may take some time to reach the seafloor and when it does, it is widely dispersed.

As with the Chevron Main Pass spill, depressions in the benthic community during and following the *Ixtoc* spill could not be linked to the oil because hydrocarbons from the blowout were not present in sediment samples (ERCO, 1982). The benthic populations were depressed following the spill compared with pre-spill conditions; however, environmental evidence was not strong enough to separate oil impacts from natural variation or possible storm damage impacts (Tunnell et al., 1981). Oil may have been present in the sediment and affected benthic communities, but weathered before sampling occurred, or oil in the water column may have affected species, but these possible factors were not measured (Rabalais, 1990).

Regardless of the speculations, field measurements indicate that the concentrations of oil that reached the seafloor were low even after uncontrolled flow for a long period of time, and the oil was vastly dispersed by the time it reached the seafloor. The inability to measure hydrocarbons in the sediment after the spill suggested that any oil that reached the seafloor had weathered rapidly. It is anticipated that similar dispersion of oil, rapid weathering, and resultant low-level, widespread concentrations of oil on the seafloor occurred with the DWH event, as indicated by the results of sediment testing (OSAT, 2010).

Long-Term Impacts

Long-term or low-level exposure may also occur to benthic infauna as a result of oil adhering to sediment. Mesocosm experiments using long-term, low-level concentrations of No. 2 fuel oil indicate acute toxicity to meiofauna due to direct oil contact and sublethal effects from sedimented oil and byproducts of the decomposition of the sedimented oil (Frithsen et al., 1985). Long-term exposure to low levels of fuel oil was shown to affect recruitment success; meiofaunal population recovery took between 2 and 7 months (Frithsen et al., 1985). These types of impacts would be expected farther from the well where oil concentrations were diluted with distance.

An increase in contamination levels in sediments can result in a decrease in trophic diversity and an increase in opportunistic pollution tolerant species (Gaston et al., 1998). Contaminated and disturbed areas are generally dominated by small, subsurface deposit feeders (Gaston et al., 1998). These small opportunistic species live at the sediment water interface and are more tolerant of contaminants (Gaston et al., 1998). Those species that can tolerate the disturbed or contaminated environment and recruit rapidly would be the initial colonizers of the area. Two pioneering Capitellid polychaetes in the Gulf of Mexico known to tolerate environmental stress are *Mediomastus californiensis* and *Notomastus latericeus*, and they can be expected in recovering areas (Gaston et al., 1998). Amphipods on the other hand, especially of the genus *Ampelisca*, are extremely sensitive to oil pollution and would not be found in the early recovery stages after hydrocarbon pollution (Gómez Gesteira and Dauvin, 2000). The pioneering community will remain until later successional organisms settle, or the pioneering stage may remain in continually disturbed areas, such as those affected by yearly hypoxia.

An alteration in the benthic trophic structure may impact food availability for fish and invertebrates. Burrowing polychaetes and subsurface deposit feeders, such as the pioneering species described above, are not important in the diets of the red drum and spotted sea trout, two commercially and recreationally important species in the Gulf of Mexico (Gaston et al., 1998). Therefore, an increase in opportunistic species will result in less available food for certain species of fish (Gaston et al., 1998). The small surface-dwelling opportunistic species, however, appear to be important in the diet of juvenile brown shrimp (McTigue and Zimmerman, 1998) and therefore may provide additional food sources for this species. Early stage successional communities, however, cannot store and regulate the nutritional energy that a later stage community can because the organisms are small and remain at the sediment surface, resulting in a less stable and productive food source for higher trophic levels (Diaz and Solow, 1999). Exposure (to the extent it might have occurred) could result in slightly altered benthic communities with opportunistic species. Recolonization and immigration for successive communities would likely then either supplant or supplement these opportunistic species.

Limited data are currently available on potential impacts of the DWH event on soft bottoms in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to soft-bottom benthic communities. Relevant data on the status of soft-bottom benthic communities after the DWH event, however, may take years to acquire and analyze. Much of this data is being developed through the NRDA process, which may take years to complete. Little data from the NRDA process have been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In the place of this incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches. The BOEM believes, however, that this incomplete or unavailable information is not essential to a reasoned choice among alternatives. Because soft bottoms are ubiquitous in the Gulf of Mexico, are not considered essential fish habitat, and are repopulated relatively quickly from neighboring communities when they are impacted, this incomplete or unavailable information is not likely to be essential to a reasoned choice among alternatives.

4.2.1.11.2. Impacts of Routine Events

Background/Introduction

The vast majority of the Gulf of Mexico seabed is comprised of soft sediments. These soft-bottom benthic communities of the CPA are described in **Chapter 4.2.1.11.1**. Impacts from routine oil and gas activities to the soft-bottom benthic communities are discussed in this section, as a majority of the oil and gas exploration would be conducted in soft seafloor sediments. Potential impact-producing factors to these communities include infrastructure emplacement, turbidity and smothering, drilling-effluent and produced-water discharges, and infrastructure removal. Disturbances of soft-bottom communities may cause localized alterations to infaunal communities and disruptions to food sources for some large invertebrate and finfish species.

It is important to note that the effects of routine events on soft-bottom benthos would only impact a very small portion of the 268,922 km^2 (103,831 mi^2) of seafloor in the CPA and in the WPA and CPA combined (384,567 km^2; 148,842 mi^2). The estimated footprint of platforms on the continental shelf in the GOM is approximately 20,170,839 ft^2 (1,873,932 m^2 or 0.724 mi^2; 1.874 km^2) (LGL Ecological Research Associates, Inc. and Science Applications International Corporation, 1998), which is 0.0005 percent of the estimated area of seafloor in the WPA and CPA combined. Based on these values, the impacts that may occur to the seafloor around platforms would be a fraction of the entire soft-bottom habitat of the GOM. Impacts from the drilling of wells are generally confined to a few hundred meters from the well and impacts decrease with distance from the well. Recovery from construction impacts should begin within a year but may take several years to complete recovery (Rhodes and Germano, 1982; Neff et al., 2000; Newell et al., 1998). Recovery would depend on the benthic community composition, sediment type, and the intensity of the disturbance. Long-term operational impacts are localized and generally result in a shift in benthic community dominance (Montagna and Harper, 1996).

Construction Impacts on Infauna and Soft-Bottom Benthic Communities

Organisms from the bacterial level up through polychaete worms and crabs inhabit the soft-bottom benthos. Many of these organisms form the base of the food chain for larger invertebrates and finfish species. Any immobile benthic organisms that are in the footprint of the infrastructure or pipeline emplacement would be physically crushed. The soft-bottom habitat would be replaced with a hard substrate for the life of the structure; for some, such as pipelines or seafloor templates that are abandoned in place at the end of their service, the substitution of hard bottom is permanent. While the substrate and community are changed, the change is generally considered an improvement in value and ecological services. This hard substrate would supply a foundation upon which encrusting organisms may settle (Gallaway and Lewbel, 1982). Encrusting organisms may include barnacles, oysters, mussels, bryozoans, hydroids, sponges, octocorals, corals, and algae (Gallaway and Lewbel, 1982). These organisms provide habitat and food for larger benthic organisms and finfish. The addition of a petroleum platform would result in a community shift from a soft-bottom infaunal community to a reef community above a soft-bottom benthic community. This shift provides more complex habitat, supporting more diverse assemblages than typical soft bottom. The shrimp trawling fishery is negatively affected to a small degree because structures create more obstacles to their trawling. There is also a reduction in trawlable area but this amount is so small compared with the available area (268,922 km^2; 103,831 mi^2) as to be insignificant.

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels are oil and gas OCS-related threats that disturb areas of the seafloor. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current (Lissner et al., 1991). Anchor damage could result in the crushing and smothering of infauna. Anchoring often destroys a wide swath of habitat by being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991).

Traditional pipeline-laying barges (as opposed to dynamically positioned barges) affect more seafloor than other anchoring impacts. These barges typically use an array of 8-12 anchors weighing about 4,500 kg (10,000 lb) each. While the large anchors crush organisms in their footprint, a much larger area is affected by anchor cable sweep as the barge is pulled forward to lay the pipeline by reeling-in forward cables and reeling-out aft cables. The anchors are reset repeatedly to forward positions to allow the barge to "crawl" forward. In this way, the anchor sweep scours parallel paths on each side of the vessel where the cables touch the seafloor. The width of the scoured paths varies with water depth (deeper water equals longer cables) and may be as much as 1,500 m (5,000 ft) to each side (only a portion of the cable adjacent to the anchor touches the seafloor). Damage to infauna as a result of anchoring may take approximately 1 year to recover, depending on the reproductive cycle and immigration of surrounding communities (Rhodes and Germano, 1982).

Another major impact of OCS-related construction is pipeline burial. In waters ≤60 m (200 ft), burial of pipelines is required. This involves trenching up to 3.3 m (10 ft) deep in the seafloor from a water depth of ≤60 m (200 ft) to shore. This is a severe disturbance of the trenched area and creates a large turbidity plume. Resuspended sediments can cause obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to areas in the vicinity of the barge. Impacts may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003).

The drilling of a well may result in water column turbidity, smothering of benthic organisms by the deposition of cuttings, coarsening of sediment near the well, trace metal contamination from cuttings, organic enrichment of the seabed, and hypoxic conditions if synthetic-based drilling fluid is used, and possible hydrocarbon contamination. Turbidity is a short-term impact as the cuttings rapidly sink to the seafloor. Burial of benthic communities and alteration of the sediment near the platform would result in the repopulation of smothered benthic habitats, possibly with different species that are adapted to coarser sediment. The impacts of long-term exposures to metals and hydrocarbons in the cuttings are discussed in the following section, as they occur during the lifetime of the project.

Drilling disposal methodology (surface disposal or bottom shunting) and drilling fluid (synthetic or water based) would result in slight differences in the dispersal of the well cuttings and drilling muds. For example, well cuttings that are disposed of at the water's surface tend to disperse in the water column and are distributed widely at low concentrations (CSA, 2004b; NRC, 1983). In areas where currents are strong, cuttings may be so widely dispersed that they are not visible on the seafloor near the platform (Zingula and Larson, 1977). In deep water, cuttings discharged at the sea surface may spread out to 1,000 m (3,280 ft) from the source, depending on currents, with the thickest layers at the well and the majority of the sediment within 250 m (820 ft) (CSA, 2006). On the other hand, cuttings that are shunted to the seafloor are concentrated over a smaller area in piles instead of being physically dispersed over wide areas (Neff, 2005). The heaviest concentrations of well cuttings and drilling fluids, for both water-based and synthetic-based drilling muds, have been reported within 100 m (328 ft) of well and are shown to decrease beyond that distance (CSA, 2004b; Kennicutt et al., 1996). Deposition may reach up to 500 m (1,640 ft) from the well, depending on surrounding environmental conditions (Kennicutt et al., 1996).

Surface-released cuttings rarely accumulate thicknesses of about 1 m (3 ft) immediately adjacent to the well; thicknesses are usually not higher than a few tens of centimeters (about 1 ft) in the GOM (Zingula and Larson, 1977). A gradient of cuttings generally settles within 100 m (328 ft) of the well site. Cuttings settle in a patchy distribution determined by water currents and limited to about 250 m (820 ft) from the well site (CSA, 2004b). Impacts would be less in shallow waters than deep waters, as the shallow water organisms have greater vertical migration ability in the sediment than the deepwater benthos (CSA, 2004b). Because cuttings are distributed unevenly and in patches, burial would likely be localized (CSA, 2004b).

The greatest impact to the benthic community may result from the shunting of cuttings to the seafloor in order to protect nearby topographic features. Cuttings that are shunted to the seafloor form concentrated thicker depositions over a smaller area of soft seafloor (Neff, 2005). Any organisms beneath heavy layers of deposited cuttings would be smothered.

Additional stress may occur if synthetic drilling fluids are used. Base fluids of synthetic drilling muds that remain on the cuttings are designed to be low in toxicity and biodegradable in offshore marine sediments (Neff et al., 2000). However, as bacteria and fungi break down the synthetic drilling fluids, the sediments may become anoxic (Neff et al., 2000). Benthic macrofaunal recovery would occur when synthetic drilling mud concentrations are reduced to levels that enable the sediment to become reoxygenated (Neff et al., 2000). Complete community recovery from synthetic drilling mud exposure may take 3-5 years (Neff et al., 2000).

Sediment grain size may be altered near the new structure. Investigations have shown that sediments were enriched with sandy material out to 100 m (328 ft) from a well (Kennicutt et al., 1996). Altered grain size can result in different species inhabiting the sediment. The shift back to fine-grained sediment can occur fairly rapidly as local marine sediment accumulates on top of the cuttings (Zingula and Larson, 1977).

Recolonization and immigration by organisms from neighboring soft-bottom substrate to the impacted areas would be expected to occur within a relatively short period of time. Initial repopulation from nearby stocks may begin with the following recruitment event and be predominantly comprised of pioneering species, such as tube-dwelling polychaetes or oligochaetes (Rhodes and Germano, 1982). Full recovery would follow as later stages of successional communities overtake the opportunistic species (Rhodes and Germano, 1982), but the time it takes to reach a climax community may vary depending on the species and degree of impact. Initial recovery should be well advanced within a year following the deposition (Neff, 2005). Because some benthic communities in the northern Gulf of Mexico are permanently in early community successional stages due to frequent disturbances, full recovery may occur very quickly (Rabalais et al., 2002a; Gaston et al., 1998; Diaz and Solow, 1999).

The seafloor begins to change once drilling is completed. Piles of cuttings are often flattened within several months of the completion of drilling, and layers of sediment blanket them (Monaghan et al., 1980). Observations recorded 8.5 months after drilling was completed at a site off Louisiana indicated that marine sediment had covered the cuttings and fauna present at the site was similar in species and abundance to a nearby location that did not experience cutting deposition (Zingula and Larson, 1977). Observations at another platform in the Gulf of Mexico indicated a complex benthic community, including burrowing organisms, 2 years after drilling was completed (Zingula and Larson, 1977). After 10-15 years, the cuttings themselves were not distinguished from surrounding sediments (Monaghan et al., 1977). As the cuttings break down, recolonization by benthic organisms increases.

Long-Term and Operational Impacts on Infauna and Soft-Bottom Benthic Communities

Exposure to Deposited Drill Cuttings and Drilling Fluids

Benthic organisms may experience long-term impacts such as exposure to contaminants, alteration in habitat, and a change in community structure as a result of offshore oil and gas production. These impacts are generally localized and occur close to the production platform (within 100-200 m [328-656 ft] from the platform) (Montagna and Harper, 1996; Kennicutt et al., 1996; Hart et al., 1989; Kennicutt, 1995; CSA, 2004b). Sand content, metals, barium, inorganic carbon, and petroleum products have all been reported to be elevated near platforms (Kennicutt, 1995). Distribution of discharges tends to be patchy, have sharp gradients, and be directional (Kennicutt, 1995). The greatest impacts occur in low energy environments where depositions may accumulate and not be redistributed (Neff, 2005; Kennicutt et al., 1996). Despite these possible impacts, it is important to consider that they occur over a very small portion of the seafloor of the Gulf of Mexico. The CPA covers 268,922 km^2 (103,831 mi^2) and is mostly soft-bottom sediment.

Long-term impacts of oil and gas production have been studied in the Gulf of Mexico Offshore Monitoring Experiment and other monitoring programs. These programs indicated that the greatest long-term impacts to benthic organisms were from the deposition of drilling muds and cuttings on the seabed. Drilling mud is primarily composed of barium. Elevated levels of barium, silver, cadmium, mercury, lead, and zinc were found out to 200 m (656 ft) from platforms and are likely a product of drilling mud and cuttings (Kennicutt et al., 1996; Hart et al., 1989; Chapman et al., 1991; CSA, 2004b). The concentrations of metals decreased with distance from the platform and were highest in low energy environments (Kennicutt et al., 1996).

Other additions of metals to sediments near offshore platforms may come from produced waters and corrosion of the structure itself. Information is contradictory on the distance from a platform that produced waters can affect benthic communities. Impacts have been reported from 100 m (328 ft) of the source to 1 km (0.6 mi) from the source (Peterson et al., 1996; Armstrong et al., 1977; Osenberg et al., 1992). Elevated levels of lead, zinc, and cadmium in sediments near platforms are most likely deposited from produced waters and corrosion of the galvanized platform itself (Kennicutt et al., 1996). Lead concentrations have been reported to continue to accumulate in sediment during the lifetime of an offshore platform (Kennicutt et al., 1996). The continual addition of metals to sediment near platforms results in continuous exposure of benthos to the metals.

Metal concentrations in sediments near gas platforms have been reported above those that may cause deleterious biological effects. Sublethal infaunal impacts have been reported out to 100 m (328 ft) from the platform. Of the species sampled, harpacticoid copepods were most sensitive to contamination. They showed reduced abundances, reduced survival, and an increased but less successful reproductive effort paired with reduced recruitment closer to platforms (Montagna and Harper, 1996; Carr et al., 1996). Copepods showed reduced genetic diversity near platforms and the production efficiency of nematodes was found to be reduced by half within 50-100 m (164-328 ft) of a platform (Montagna and Li, 1997; Kennicutt, 1995). The impacts are believed to be a result of metal toxicity originating from drill cuttings that remain in the sediment during the installation of the well (Montagna and Harper, 1996; Carr et al., 1996).

Lethal impacts may also occur near the wells due to localized elevated metal concentrations in sediments from cuttings. Porewater toxicity as a result of metal contamination was detected near gas platforms (Carr et al., 1996). Sea urchin fertilization and embryological development were reduced within 150 m (492 ft) from gas platforms, as was polychaete reproduction and copepod nauplii survival (Carr et al., 1996; Kennicutt, 1995).

Hydrocarbon contamination as a result of regular gas production activities is relatively low (Montagna and Harper, 1996). Hydrocarbon enrichment has been reported within 25 m (82 ft) and out to 200 m (656 ft) of petroleum platforms, and the concentrations decreased with distance from the platforms (Hart et al., 1989; Chapman et al., 1991; Kennicutt, 1995; Kennicutt et al., 1996). The concentrations of PAH’s in the sediment surrounding platforms, however, were below the biological thresholds for marine organisms and appeared to have little effect on benthic organisms (Hart et al., 1989; McDonald et al., 1996; Kennicutt et al., 1996). Other studies indicated that chronic low-level discharges from petroleum production in the northern Gulf of Mexico did not result in hydrocarbons accumulating to stressful levels in benthic organisms or resultant organism responses to the hydrocarbons (Sharp and Appan, 1982).

It is anticipated that hydrocarbon contamination at oil-producing wells is higher than for gas wells (Carr et al., 1996). Unlike with metals, links between petroleum products and benthic impacts are not established (Holdway, 2002; Southwest Research Institute, 1981). It is possible that petroleum hydrocarbons in drilling muds and cuttings may cause toxicity to benthic organisms and bioaccumulate up the food chain; however, very little information is available on such impacts (Neff, 2005). It is also possible that continuous influx of contaminants from the Mississippi River and periodic flooding and storms mask the impact to benthic organisms from chronic exposure to petroleum production (Southwest Research Institute, 1981). Variation in natural environments also makes it difficult to determine a link between petroleum production impacts and natural environmental impacts on benthic communities (Holdway, 2002). Although concrete information on the link of hydrocarbon contamination and benthic impacts would be relevant, it is not essential to a reasoned choice among alternatives. As described below, there is credible information, applied using accepted scientific methodologies, regarding what the potential impacts to benthic communities may be from hydrocarbons and related contaminants.

The sedimentary environment surrounding a well may be altered by the disposal of cuttings on the seafloor. The sediment grain size near petroleum platforms was reportedly larger and enriched with sand compared with the surrounding environment (Kennicutt et al., 1996). Sediment was coarser within 100 m (328 ft) of a discharge site and sediment alterations have been reported out to 500 m (1,640 ft), depending on the surrounding environment and method of disposal (surface disposal or bottom shunting) (CSA, 2004b; Kennicutt et al., 1996). Sediment was coarser near the platform, becoming finer with distance (Hart et al., 1989; Kennicutt, 1995). The field of impact is not heterogeneous and there are often concentration gradients within the discharged material, which is often deposited directionally as it is carried by water currents (Kennicutt, 1995).

Metal and hydrocarbon concentrations and altered sediment characteristics near wells may result in an altered benthic population surrounding the production platform. Significant impacts to benthos as a result of sediment alteration were measured within a few hundred meters of petroleum platforms (Kennicutt, 1995). The benthic assemblages within 150 m (492 ft) of some wells differed from the infaunal deposit-feeding species farther from the well (Hart et al., 1989). Epifaunal organisms can be sloughed from the platform to the surrounding seafloor and the bottom community surrounding the platform may be similar to those associated with shell reefs, rubble bottoms, and hard substrates (Hart et al., 1989). The infaunal deposit-feeding species that are typical of the Gulf of Mexico seafloor become more prevalent with distance from the well.

Contaminants also reportedly altered benthic community structure in a 25- to 100-m (82- to 328-ft) radius surrounding platforms (Chapman et al., 1991; Montagna and Harper, 1996). In general, polychaetes, bivalves, nemerteans, decapods, and isopods all increased near platforms, while amphipods and foraminiferans, which are more sensitive to contamination, decreased near platforms and increased with distance from the well (Chapman et al., 1991; Montagna and Harper, 1996; Kennicutt, 1995). Deposit feeders are generally much less sensitive to environmental contaminants than the crustaceans, and reduced crustacean populations are likely the result of elevated metal concentrations near platforms resulting from well drilling, produced waters, and corrosion of the structure (Peterson et al., 1996).

Mobile epifaunal organisms do not show trends associated with distance from platforms. Instead, each platform is a unique community that is influenced by the physical and chemical parameters of the platform itself (Ellis et al., 1996). The platforms, however, act as artificial reefs, attracting encrusting organisms to the introduced structure. The colonization of platforms and resultant attraction of fish and mobile invertebrates may result in localized organic enrichment in sediments near the platforms (Montagna and Harper, 1996). Organic enrichment has been reported within 100 m (328 ft) of wells and may alter benthic communities where sediment is enriched (CSA, 2004b). Enriched sediments may lead to increased infaunal deposit-feeder density and diversity near platforms as reported by Montagna and Harper (1996). The number of organisms was reportedly greater within 100 m (328 ft) of platforms, most likely due to the organic enrichment near platforms (Kennicutt, 1995). Surveys indicate that, although the number of organisms was high within this radius, species diversity was low and dominated by a few opportunistic species (CSA, 2004b). Elevated, nonselective, deposit-feeding populations near platforms are likely the combined result of enriched organic material near the platforms as a result of "organic shedding" from platforms and opportunistic species populating defaunated sediment as a result of metal toxicity or anaerobic conditions (Peterson et al., 1996; Kennicutt, 1995; CSA, 2004b). Deposit feeders are able to utilize organic material in polluted areas as a food source, allowing them to feed in areas other organisms cannot tolerate (Peterson et al., 1996). Bivalves may also be found in organically enriched areas as many bivalves are able to tolerate low dissolved oxygen levels that can occur in such environments (CSA, 2004b).

Synthetic drilling fluids are designed to be nontoxic to marine organisms; however, as bacteria and fungi break down the synthetic drilling fluids, the sediments may become anoxic (Neff et al., 2000). The time it takes for the sediment to hold enough oxygen for organisms to populate the area may take several years (Neff et al., 2000). The time between drilling and repopulation may result in an altered benthic community. Monitoring of a drill site indicated that sediments out to 75 m (246 ft) from the site were anaerobic 4 months after drilling and benthic infauna abundance was low out to 200 m (656 ft) (CSA, 2004b). The opportunistic polychaete, *Capitella capitata*, was abundant out to 125 m (410 ft) from the drill site but was not found beyond 200 m (656 ft) from the well (CSA, 2004b). Evidence of recovery was observed a year after drilling occurred, especially at stations greater than 75 m (246 ft) from the well (CSA, 2004b). After 2 years, community structure had recovered, but species composition was slightly altered (CSA, 2004b). Biological effects appear to be a result of the organic enrichment from synthetic-based drilling fluid, and the resultant biodegradation and anaerobic conditions (CSA, 2004b).

It should be noted that the combined impacts of drilling wells may lead to unexpected ecological interactions surrounding wells. For example, infaunal deposit feeders are usually associated with finer sediments, but they are seen in the coarser sediments close to platforms. This is probably due to both tolerance to contaminants in the sediment and their ability to utilize organic enrichment in the sediment deposited by higher tropic levels or from the breakdown of synthetic drilling fluids. Epifaunal organisms, however, are those that associate with coarser sediments and reefs, as there is substrate on the reef and larger material in the sediment for attachment. These alterations lead to a local altered environment that is specific to each platform and its impacts on the surrounding environment (Montagna and Harper, 1996; Hart et al., 1989; Ellis et al., 1996).

An alteration in the benthic community may impact food availability for fish and invertebrates. Burrowing polychaetes and subsurface deposit feeders are not important in the diets of the red drum and spotted sea trout, two commercially and recreationally important species in the Gulf of Mexico (Gaston et al., 1998). Therefore, an increase in opportunistic species would result in less available food for certain species of fish (Gaston et al., 1998). The small surface-dwelling opportunistic species, however, appear to be important in the diet of juvenile brown shrimp (McTigue and Zimmerman, 1998) and therefore may provide additional food sources for this species. Early stage successional communities, however, cannot store and regulate the nutritional energy that a later stage community can because the organisms are small and remain at the sediment surface, resulting in a less stable and productive food source for higher trophic levels (Diaz and Solow, 1999). This impact on higher trophic levels may last as long as the alteration in benthic community structure does.

Exposure to Produced Water

Produced waters are discharged at the water surface throughout the lifetime of the production platform and may contain hydrocarbons, trace metals, elemental sulfur, and radionuclides (Kendall and Rainey, 1991). Heavy metals enriched in the produced waters include cadmium, lead, iron, and barium (Trefry et al., 1995). Produced waters may impact both organisms attached to the production platform and benthic organisms in the sediment beneath the platform because the elements in the produced water may remain in the water column or attach to particles and settle to the seafloor (Burns et al., 1999). A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in **Chapter 4.2.1.2**.

Produced waters are rapidly diluted and impacts are generally only observed within proximity of the discharge point (Gittings et al., 1992a). Models have indicated that the vertical descent of a surface originating plume should be limited to the upper 50 m (164 ft) of the water column and maximum concentrations of surface plume water have been measured in the field between 8 and 12 m (26 and 39 ft) (Ray, 1998; Smith et al., 1994). Plumes have been measured to dilute 100 times within 10 m (33 ft) of the discharge and 1,000 times within 103 m (338 ft) of the discharge (Smith et al., 1994). Modeling exercises showed hydrocarbons to dilute 8,000 times within 1 km (0.6 mi) of a platform and constituents such as benzene and toluene to dilute 150,000 and 70,000 times, respectively, within that distance (Burns et al., 1999).

The less soluble fractions of the constituents in produced water associate with suspended particles and may sink (Burns et al., 1999). Particulate components were reported to fall out of suspension within 0.5-1 nmi (0.3-0.6 mi; 0.9-1.9 km) from the source outfall (Burns et al., 1999). The particulate fraction disperses widely with distance from the outfall and soluble components dissolve in the water column, leaving the larger, less bioavailable compounds on the settling material (Burns et al., 1999).

Water-borne constituents of produced waters can influence biological activity at a greater distance from the platform than particulate components can (Osenberg et al., 1992). The waterborne fractions travel with currents; however, data suggest that these fractions remain in the surface layers of the water column (Burns et al., 1999). Measurements of toluene, the most common dissolved hydrocarbon in produced waters, revealed rapid dilution with concentrations between 1 and 10 nanograms/liter (0.000001-0.00001 ppm) less than 2 km (1 mi) directly down current from the source and rapid dispersion much closer to the source opposite the current (King and McAllister, 1998). Modeling data for a platform in Australia indicated the plume to remain in the surface mixed layer (top 10 m; 33 ft) of the water column, which would protect seafloor organisms from encountering the waterborne constituents of produced waters.

Acute effects caused by produced waters are likely only to occur within the mixing zone around the outfall (Holdway, 2002). Past evaluation of the bioaccumulation of offshore, produced-water discharges conducted by the Offshore Operators Committee (Ray, 1998) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Possibly toxic concentrations of produced water were reported 20 m (66 ft) from the discharge in both the sediment and the water column where elevated levels of hydrocarbons, lead, and barium occurred, but no impacts to marine organisms or sediment contamination were reported beyond 100 m (328 ft) of the discharge (Neff and Sauer, 1991; Trefry et al., 1995). Another study in Australia reported that the average total concentration of 20 aromatic hydrocarbons measured in the water column 20 m (66 ft) from a discharge was less than 0.5μg/L (0.0005 mg/L or 0.0005 ppm) due to the rapid dispersion of the produced-water plume (Terrens and Tait, 1996).

Compounds found in produced waters are not anticipated to bioaccumulate in marine organisms. A study conducted on two species of mollusk and five species of fish (Ray, 1998) found that naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals. Metals including: barium, cadmium, mercury, nickel, lead, and vanadium in the tissue of the clam, *Chama macerophylla*, and the oyster, *Crassostrea virginica*, collected within 10 m (33 ft) of discharge pipes on oil platforms were not statistically different from reference stations (Trefry et al., 1995). Because high-molecular weight PAH's are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and they were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers (Ray, 1998).

Chronic effects including decreased fecundity; altered larval development, viability, and settlement; reduced recruitment; reduced growth; reduced photosynthesis by phytoplankton; reduced bacterial growth; alteration of community composition; and bioaccumulation of contaminants were reported for benthic organisms close to discharges and out to 1,000 m (3,281 ft) from the discharge (Holdway, 2002; Burns et al., 1999). Effects were greater closer to the discharges and responses varied by species; therefore, high concentrations of produced waters may have a chronic effect on organisms on or adjacent to the platform.

Produced waters should only impact localized populations of the soft-bottom biota. The greatest impacts are reported adjacent to the discharge and are substantially reduced less than 100 m (328 ft) from the discharge. Also, USEPA's general NPDES permit restrictions on the discharge of produced water, which require the effluent concentration 100 m (656 ft) from the outfall to be less than the 7-day "no observable effect concentration" based on laboratory exposures, would help to limit the impacts on biological resources nearby (Smith et al., 1994). Measurements taken from a platform in the Gulf of Mexico showed discharge to be diluted below the no observable effect concentration within 10 m (33 ft) of the discharge (Smith et al., 1994). Such low concentrations would be expected to be even further diluted at greater distances from the well.

Structure-Removal Impacts

The impacts of structure removal on soft-bottom benthic communities can include turbidity, sediment deposition, explosive shock-wave impacts, and loss of habitat. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity. Suspended sediment may evoke physiological impacts in benthic organisms including "changes in respiration rate, . . . abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003). The higher the concentration of suspended sediment in the water column and the longer the sediment remains suspended, the greater the impact. Also, different species have differing tolerances to suspended sediment. In general, polychaete worms can withstand much higher concentrations of suspended sediment in the water column than amphipods (Swanson et al., 2003). Bivalves can withstand high concentrations of suspended sediment by reducing net pumping rates and rejecting material in pseudofeces (Clarke and Wilber, 2000). Mobile organisms have a much better chance of escaping high suspended sediment concentrations and the possible resultant smothering than sessile organisms do because they can avoid areas of disturbance (Clarke and Wilber, 2000).

Structural removal may also result in resuspension of contaminated sediments (Schroeder and Love, 2004). The impact to benthic organisms as a result of contaminant exposure from suspended sediments is dependent on many variables and not well understood (Eggleton and Thomas, 2004). Acute toxicity, chronic impacts, and bioavailability would all be dependent on the changes in the physical and chemical environment as a result of the disturbance.

Sediment deposition may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, reducing light intensity, and causing physical abrasion (Wilber et al., 2005). Many benthic organisms have the ability to tolerate some sedimentation, as they experience it through natural processes (Wilber et al., 2005). For example, organisms may vertically migrate up through deposited sediment (Wilber et al., 2005). If a different size sediment is deposited on the seafloor than what is presently there, the impacts may be greater than if the same grain size was deposited, and the habitat may be altered as a result (Wilber et al., 2005).

The shock waves produced by explosive structure removals damage some benthic organisms in the near vicinity of the blasts. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure-removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m (25 ft) away from the detonation of 135-kg (29-lb) charges in open water incurred a 5 percent mortality rate. Very few crabs died when exposed to 14-kg (31-lb) charges in open water 46 m (150 ft) away from the explosions. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Impacts to invertebrates are anticipated to be minimal as they do not have air bladders inside their bodies that may burst with explosions as some fish do (Schroeder and Love, 2004).

Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock wave is significantly attenuated when explosives are buried as opposed to detonation in the water column (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m (15 ft) below the seabed, as required by BSEE regulations, would attenuate blast effects (Wright and Hopky, 1998).

Infrastructure or pipeline removal would impact both the communities that have colonized the structures and the soft-bottom benthos surrounding the structure. Removal of the structure itself would result in the removal of the hard substrate and encrusting community. The overall community would experience a reduction in species diversity (both epifaunal encrusting organisms and the fish and large invertebrates that fed on them) with the removal of the structure (Schroerer and Love, 2004). The epifaunal organisms attached to the platform that are physically removed would die once the platform is removed. However, the seafloor habitat would return to the original soft-bottom substrate that existed before the well was drilled.

Some structures may be converted to artificial reefs. If the platform stays in place, the hard substrate and encrusting communities would remain part of the benthic habitat. The diversity of the community would not change and associated finfish species would continue to graze on the encrusting organisms. The community would remain an active artificial reef. However, the plugging of wells and other reef in place decommissioning activities would still impact benthic communities as discussed above, since all the steps for removal except final removal from the water would still occur.

Proposed Action Analysis

As mentioned earlier, a majority of the seafloor of the Gulf of Mexico is soft-bottom sediments. Drilling activities would occur directly in these soft substrates; however, these routine activities would only affect a small portion of the substrate and benthic communities of the Gulf of Mexico. The CPA covers 268,922 km^2 (103,831 mi^2). Routine operations may affect soft-bottom benthic communities through infrastructure emplacement, turbidity, sedimentation, drilling effluent discharges, and produced-water discharges. Of the small area affected, the resultant impacts from drilling and produced-water discharges have been measured to reach only about 100-500 m (328-1,640 ft) from the production well.

For a CPA proposed action, 86-167 exploration and delineation and 110-210 development and production wells are projected for water depths of 0-200 m (0-656 ft) (**Table 3-3**). Cuttings from the wells would be released at the sea surface and dispersed in the water column, resulting in a widespread deposition on the seafloor. Deposition thickness would be patchy, but it should only accumulate a few centimeters to possibly a meter on the seafloor (beside the well) (CSA, 2004b and 2006). Benthic organisms are anticipated to either vertically migrate through the widespread depositional layers or immigrants would repopulate the smothered habitat. Altered community structure may occur as a result of the environmental changes, but this alteration would be limited to a few hundred meters from the well.

If any of these wells are proposed near a topographic feature, no discharges would take place within the feature's No Activity Zone. The drilling discharges would be shunted to within 10 m (33 ft) of the seafloor either within the 1,000-Meter Zone, 1-Mile Zone, 3-Mile Zone, or 4-Mile Zone (depending on the topographic feature) around the No Activity Zone (see **Chapter 2.4.1.3.1** for specifics). This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It would, however, result in heavy layers of cuttings on the seafloor, which could smother underlying benthic communities and create turbid waters in a localized area near the well. Seafloor depositions resulting from shunted cuttings have been measured a distance of 1,000 m (3,280 ft) in a gradient of declining density with distance from the well (Kennicutt et al., 1996; CSA, 2006). Benthic organisms may not be able to vertically migrate through the heavy depositional layers near the well, but it is anticipated that they would repopulate the areas through the reproduction and immigration of nearby stocks. Altered community structure may occur as a result of environmental changes, but this alteration would be limited to a few hundred meters from the well.

For a CPA proposed action, 31-60 production structures are projected for water depths of 0-200 m (0-656 ft) (**Table 3-3**). Between 18 and 36 structure removals using explosives are projected between the shoreline and 60 m (197 ft) of water and 2-4 structure removals are projected offshore between 60 and 200 m (197 and 656 ft) of water (**Table 3-3**). The explosive removals of platforms may impact the biota through suspended sediment, sediment redeposition and smothering, explosive shock, and loss of hard substrate habitat. Communities, however, are anticipated to recover. Turbidity impacts would be short lived, and many organisms are tolerant of short-term increases in turbidity. Repopulation of the area disturbed by burial and shock-wave effects would begin within 6 months to a year, although it may take several years for complete recovery (Rhodes and Germano, 1982; Neff et al., 2000; Newell et al., 1998). And although the hard substrate that provided structure for encrusting organisms that created an artificial reef habitat may be removed, the environment would return to its previous state as a soft-bottom infaunal community.

Summary and Conclusion

Although localized impacts to comparatively small areas of the soft-bottom benthic habitats would occur, the impacts would be on a relatively small area of the seafloor compared with the overall area of the seafloor of the CPA (268,922 km^2; 103,831 mi^2). The greatest impact is the alteration of benthic communities as a result of smothering, chemical toxicity, and substrate change. Communities that are smothered by cuttings repopulate, and populations that are eliminated as a result of sediment toxicity or organic enrichment would be taken over by more tolerant species. The community alterations are not so much the introduction of a new benthic community as a shift in species dominance (Montagna and Harper, 1996). These localized impacts generally occur within a few hundred meters of platforms, and the greatest impacts are seen close to the platform. These patchy habitats within the Gulf of Mexico are probably not very different from the early successional communities that predominate throughout areas of the Gulf of Mexico that are frequently disturbed (Rabalais et al., 2002a; Gaston et al., 1998; Diaz and Solow, 1999).

4.2.1.11.3. Impacts of Accidental Events

Background/Introduction

The majority of the seafloor of the Gulf of Mexico is comprised of soft substrate. The soft-bottom benthic communities of the CPA are described in **Chapter 4.2.1.11.1**. Any activity that may affect the soft-bottom communities would only impact a small portion of the overall area of the seafloor of the Gulf of Mexico. The soft-bottom substrate is ubiquitous throughout the Gulf of Mexico. Although the likelihood of a low-probability, large-volume catastrophic spill remains remote (**Appendix B**), the types or kinds of impacts to soft-bottom communities would likely be the same for a smaller scale accidental event. As such, the analysis below addresses both types of spills.

Possible Modes of Exposure

Oil released to the environment as a result of an accidental event may impact soft-bottom benthic communities in several ways. Oil may be physically mixed into the water column from the sea surface, injected below the sea surface and travel with currents, dispersed in the water column, or sedimented to particles and sink to the seafloor. These scenarios and their possible impacts are discussed in the following sections.

An oil spill that occurs at the sea surface would result in a majority of the oil remaining at the sea surface. Lighter compounds in the oil may evaporate and some components of the oil may dissolve in the seawater. Evaporation allows the removal of the most toxic components of the oil, while dissolution may allow bioavailability of hydrocarbons to marine organisms for a brief period of time (Lewis and Aurand, 1997). Remnants of the oil may then emulsify with water or adhere to particles and fall to the seafloor.

A spill that occurs below the sea surface (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would result in most of the released oil rising to the sea surface. All known reserves in the Gulf of Mexico have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. As discussed in **Chapter 3.2.1.5.4**, oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column, surfacing almost directly over the source location, thus not impacting sensitive benthic communities. If the leak is deep in the water column and the oil is ejected under pressure, oil droplets may become entrained deep in the water column (Boehm and Fiest, 1982). The upward movement of the oil may be reduced if methane in the oil is dissolved at the high underwater pressures, reducing the oil's buoyancy (Adcroft et al., 2010). The large oil droplets would rise to the sea surface, but the smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010). Oil droplets less than 100 μm (0.004 in) in diameter may remain in the water column for several months (Joint Analysis Group, 2010a). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles.

Impacts that may occur to soft-bottom benthic communities as a result of a spill would depend on the type of spill, distance from the spill, and surrounding physical characteristics of the environment. As described above, most of the oil released from a spill would rise to the sea surface, therefore, reducing the impact to benthic communities by direct oil exposure. However, small droplets of oil that are entrained in the water column for extended periods of time would migrate within the water column. Although these small oil droplets would not sink themselves, they may attach to suspended particles in the water column and then be deposited on the seafloor (McAuliffe et al., 1975). Exposure to subsea plumes, dispersed oil, or sedimented oil may result in impacts such as smothering, reduced recruitment success, reduced growth, toxicity to larvae, alteration of embryonic development, and altered community structure. These impacts are discussed in the following sections.

Surface Slick and Physical Mixing

Surface oil slicks can spread over a large area; however, the majority of the slick is comprised of a very thin surface layer of oil moved by winds and currents (Lewis and Aurand, 1997). The potential of surface oil slicks to affect benthic habitats is limited by its ability to mix into the water column. Soft-bottom benthic communities below 10-20 m (33-66 ft) water depth are protected from surface oil because of its lack of ability to mix with water (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Benthic organisms would not become physically coated or smothered by surface oil. However, if this surface oil makes its way into the water column through physical mixing, the use of dispersants, or adhering to particles in the water column, benthic communities may be impacted.

Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10 m (33 ft). Modeling exercises have indicated that oil may reach a depth of 20 m (66 ft). Yet at this depth, the spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Therefore, soft-bottom benthic communities located in shallow water have the potential to be fouled by oil that is floating on shallow water if it mixes to the depth of the seafloor. Nearshore oil deposits that occur in sheltered areas, such as bays, may remain in the sediment and impact organisms for long periods. Oil in nearshore sediments was found in high concentrations 8 years following the *Exxon Valdez* spill (Dean and Jewett, 2001). Benthic communities located in deeper water should not be impacted by oil physically mixed into the water column. However, if dispersants are used, they would enable oil to mix into the water column and possibly impact organisms in deeper water. Dispersants are discussed later in this section.

Subsurface Plumes

A subsurface oil spill or plume has the potential to reach a soft-bottom benthic community and cause negative effects. Such impacts on the biota may have severe and long-lasting consequences, including loss of habitat and biodiversity; change in community structure; toxicity to adults, larvae, and embryos; and failed reproductive success.

A subsurface plume that contacts the seafloor may result in acute toxicity. The water accommodated fraction (WAF) or water soluble fraction (WSF) of oil that dissolves in water may be the most toxic to organisms, especially larvae and embryos in the water column or at the water sediment interface. Lethal effects for marine invertebrates have been reported at exposures between 0.10 ppm to 100 ppm WSF of oil (Suchanek, 1993). The WSF of petroleum hydrocarbons was reportedly highly toxic to the embryos of oysters and sea urchins, while sediment containing weathered fuel was not toxic to the same species (Beiras and Saco-Álvarez, 2006). Quahog clam embryos and larvae also experienced toxicity and deformation of several different crude oils at WSF concentrations between 0.10 ppm and 10 ppm (Byrne and Calder, 1977). An experiment indicated that the WSF of No. 2 fuel oil at a concentration of 5 ppm disrupted the cellular development of 270 out of 300 test organisms within 3 hours of exposure (Byrne, 1989). After 48 hours exposure, all of the test organisms died and the 48-hour LC_{50} (lethal concentration for 50 percent of the test population) was calculated to be 0.59 ppm (Byrne, 1989). Another experiment indicated that a WSF of 0.6 ppm and greater of No. 2 fuel oil depressed respiration, reduced mobility of sperm, interfered with cell fertilization and embryonic cleavage, and retarded larval development of sand dollar eggs (Nicol et al., 1977). Experiments that exposed sea urchin embryos to 10-30 ppm WSF of diesel oil for 15-45 days resulted in defective embryonic development and nonviable offspring (Vashchenko, 1980). Based on the above data, dissolved petroleum hydrocarbon constituents that reach larval benthic organisms may cause acute toxicity and other developmental effects to this life stage. The WAF, however, is based on a closed experimental system in equilibrium and may be artificially low for the Gulf of Mexico, which will not reach equilibrium with contaminants. These experimental values should therefore be considered a conservative approach that would tend to overestimate impacts.

Sublethal responses of marine invertebrates may result in population level changes (Suchanek, 1993). Such sublethal responses may occur at concentrations as low as 1-10 ppb (Hyland and Schneider, 1976). Sublethal impacts may include reduced feeding rates, reduced ability to detect food, ciliary inhibition, reduced movement, decreased aggression, and altered respiration (Suchanek, 1993).

The farther a subsea plume travels, the more physical and biological changes occur to the oil before it reaches benthic organisms. Oil becomes diluted as it physically mixes with the surrounding water, and some evaporation may occur from surface slicks. The most toxic compounds of oil are lost within the first 24 hours of a spill, leaving the heavier, less toxic compounds in the system (Ganning et al., 1984). Water currents could carry a plume to contact the seafloor directly but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (ITOPF, 2002; Kingston et al., 1995). Oil also would reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). The longer and farther a subsea plume travels in the sea, the more dilute the oil will be (Vandermeulen, 1982; Tkalich and Chan, 2002). In addition, microbial degradation of the oil occurs in the water column, reducing toxicity (Hazen et al., 2010; McAuliffe et al., 1981b). The oil will move in the direction of prevailing currents (S.L. Ross Environmental Research Ltd., 1997) and although the oil will weather with the distance it travels, low levels of oil transported in subsea plumes may impact benthic communities. These mechanisms would result in a wide distribution of small amounts of oil and because the oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, scattered microhabitats with an enriched carbon environment may result (Hazen et al., 2010).

Dispersed Oil

Chemically dispersed oil from a surface slick is not anticipated to result in lethal exposures to organisms on the seafloor. The chemical dispersion of oil may increase the weathering process and allow surface oil to penetrate to greater depths than physical mixing would permit, and the dispersed oil generally remains below the water's surface (McAuliffe et al., 1981b; Lewis and Aurand, 1997). However, reports on dispersant usage on surface plumes indicates that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft)

(McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to stick to particles in the water column, slowing its rate of precipitation to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997). However, the use of dispersant increases oil concentrations in the water column, ultimately leading to precipitation on the seafloor in some form (Whittle et al., 1982).

Field experiments designed to test dispersant use on oil spills reported dispersed oil concentrations between 1 and 3 ppm, 9 m (30 ft) below the sea surface, approximately 1 hour after treatment with dispersant (McAuliffe et al., 1981a and 1981b). Other studies indicated that dispersed oil concentrations were <1 ppm, 10 m (33 ft) below the sea surface (Lewis and Aurand, 1997). The above data indicate that the mixing depth of dispersed oil is less than the depths of the majority of the Gulf of Mexico. Oil plumes are carried by water currents; some of these currents may carry subsea plumes toward shore, reaching water shallow enough for the plume to impinge on the seafloor. Unless the source of the oil is in shallow water, the dispersed oil would likely be widely diffused by the time it reaches shallow water. Most currents, however, would move laterally along depth contours rather than approaching shore, since the shore acts as a barrier containing the water, much like a levee bounding a river; inshore water would have to be displaced for offshore currents to move shoreward. Therefore, most subsea oil plumes would continue in oceanic currents until the oil is deposited to the seafloor over time by flocculation (clumping), planktonic consumption and excretion, or bacterial biodegradation (eventually bacteria die and fall to the seafloor) (Hazen et al., 2010; ITOPF, 2002; Kingston et al., 1995). This pattern would result in distribution of tiny quantities of oil that are widely scattered over a very large area. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010).

Any dispersed surface oil that may reach the benthic communities in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a). Such concentrations may not be life threatening to adult stages, but may harm larval or embryonic life stages of benthic organisms (Fucik et al., 1995; Suchanek, 1993; Beiras and Saco-Álvarez, 2006; Byrne, 1989). The LC_{50} for blue crab, white shrimp, and brown shrimp exposed to western and central Gulf of Mexico oil dispersed with COREXIT 9527 experienced toxicity of 50 percent of the test population at concentrations an order of magnitude greater than what is expected for dispersed oil in the environment (Fucik et al., 1995). Any dispersed oil in the water column that comes in contact with benthic organisms, however, may evoke short-term negative responses by the organisms or altered embryonic survival and development such as that discussed in the subsurface plumes section.

Dispersants that are used on oil below the sea surface can travel with currents through the water and may contact benthic organisms on the seafloor. It is possible that the dispersed oil could be concentrated enough to harm a benthic community near the oil's source. However, the longer the oil remains suspended in the water column traveling with currents, the more it would disperse. Weathering would also be accelerated and biological toxicity reduced (McAuliffe et al., 1981b). Although the use of subsea dispersants is a new technique and very little data are available on dispersion rates, it is anticipated that any oil that could reach the seafloor would be in low concentration based on surface slick dilution data (McAuliffe et al., 1981a; Lewis and Aurand, 1997). Therefore, impacts resulting from exposure to dispersed oil, except possibly for communities very close to applications, are anticipated to be sublethal.

Soft-bottom infaunal communities near the oil spill that are negatively impacted by direct contact with oil or dispersed oil may experience sublethal and/or lethal effects. Localized areas of lethal effects would be recolonized by populations from neighboring soft-bottom substrate once the oil in the sediment has been sufficiently reduced to support marine life (Sanders et al., 1980). This initial recolonization process may be fairly rapid, but full recovery may take up to 10 years, depending on the species present, substrate in the area, toxicity of oil spilled, concentration and dispersion of oil spilled, and surrounding environmental factors that may also affect recruitment (Kingston et al., 1995; Gómez Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). Opportunistic species would take advantage of the barren sediment, repopulating impacted areas first. These species may occur within the first recruitment cycle of the surrounding populations or from species immigration from surrounding stocks, and they may maintain a stronghold in the area until community succession proceeds (Rhodes and Germano, 1982; Sanders et al., 1980).

Oil Adsorbed to Sediment Particles

Smaller suspended oil droplets could be carried to the seafloor as a result of oil droplets adhering to suspended particles in the water column. Smaller particles have a greater affinity for oil (Lewis and Aurand, 1997). Oil may also reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Oiled sediment that settles to the seafloor may affect benthic organisms. It is anticipated that the greatest amount of sedimented oil would occur close to the spill, with lesser concentrations farther from the source. Studies after a spill that occurred at the Chevron Main Pass Block 41C Platform in the northern Gulf of Mexico revealed that the highest concentrations of oil in the sediment were close to the platform and that the oil settled to the seafloor within 5-10 mi (8-16 km) of the spill site (McAuliffe et al., 1975). Therefore, the benthic communities closest to the source of a spill may become smothered by the particles and exposed to toxic hydrocarbons.

Oiled sediment depositional impacts, however, are possible as a result of an oil spill and may smother nearby benthic species. Organisms that are physically smothered by sedimented oil, or the oil itself, may experience reduced respiration and inhibition of movement, and mobile organisms may experience additional weight or shearing forces from the sedimented oil (Suchanek, 1993). Barnacles, for example, are extremely tolerant to oil exposure but would die if smothered by it (Suchanek, 1993).

Locations closest to the oil spill would have elevated contaminant levels in sediments. Deposition of sedimented oil is anticipated to begin occurring within days or weeks of the spill and may be fairly deep (Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000). Oily sand layers were reported to be 10 cm (4 in) deep on the seafloor near the *Amoco Cadiz* spill (Gómez Gesteira and Dauvin, 2000). Acute toxicity may occur near the spill, eliminating benthic communities. As the benthic species recolonize the area, there would be a reduced trophic diversity and an increase in opportunistic pollution tolerant species (Gaston et al., 1998).

Those species that can tolerate the disturbed or contaminated environment and can recruit from neighboring or nearby areas rapidly would be the initial colonizers of the impacted area. Recolonization and immigration by organisms from neighboring soft-bottom substrate to the impacted areas would be expected to occur within a relatively short period of time. Initial repopulation from nearby stocks may begin with the following recruitment event and be predominantly comprised of pioneering species, such as tube-dwelling polychaetes or oligochaetes (Rhodes and Germano, 1982). The contaminated or disturbed area would be initially dominated by small, opportunistic, subsurface deposit feeders that inhabit the sediment water interface and are more tolerant of contaminants (Gaston et al., 1998). Two pioneering Capitellid polychaetes in the Gulf of Mexico known to tolerate environmental stress are *Mediomastus californiensis* and *Notomastus latericeus*, and they would be the first to inhabit recovering areas (Gaston et al., 1998). Amphipods on the other hand, especially of the genus *Ampelisca*, are extremely sensitive to oil pollution and would not be found in the early recovery stages after hydrocarbon pollution (Gómez Gesteira and Dauvin, 2000). Full recovery would follow as later stages of successional communities overtake the opportunistic species (Rhodes and Germano, 1982), but the time it takes to reach a climax community may vary depending on the species and degree of impact. Initial recovery should be well advanced within a year following the deposition (Neff, 2005). Because some benthic communities in the northern Gulf of Mexico are permanently in early community successional stages due to frequent disturbances, full recovery may occur very quickly (Rabalais et al., 2002a; Gaston et al., 1998; Diaz and Solow, 1999).

Experiments and field data indicate that benthic recovery would take approximately 1 year to occur. For example, a study of the recolonization and succession of subtidal macrobenthos in sediment contaminated with petroleum hydrocarbons indicated that recovery to pre-oiling conditions took 11 months (Lu and Wu, 2006). Initial colonization occurred within the first month of the study and polychaetes dominated the population (Lu and Wu, 2006). A crest after 3 months occurred with polychaetes being dominant, then at 6 months a peak occurred with bivalves dominating, followed by a decline in number of organisms and a leveling off of the community at 11 months (Lu and Wu, 2006). A similar time scale was observed in Corpus Christi Bay, Texas, where recovery from dredge material placement occurred after 1 year (Wilber et al., 2008). Recovery of benthic populations in soft subtidal environments, however, has been reported to take up to 5-10 years after oiling (Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000). The overall recovery would depend on the extent of oiling, presence of recolonizers nearby, time of year for reproduction of those colonizers, currents and water circulation patterns, and the ability of the recolonizers to tolerate the sediment conditions (Ganning et al., 1984).

Certain species are more sensitive to oil than others. Crustaceans, for example, are very sensitive to oil and have disappeared from oiled environments and had slow returns to the oiled areas (Dean and Jewett, 2001; Gómez Gesteria and Dauvin, 2000). The amphipod, *Ampelisca* sp., which disappeared from some sediments after the *Amoco Cadiz* oil spill took 2 years to begin repopulating areas, as the sediments decreased in contamination (Gómez Gesteira and Dauvin, 2000). Polychaetes, on the other hand, are much less sensitive to oil pollution and may experience population booms in contaminated areas (Gómez Gesteira and Dauvin, 2000).

The benthic population may be altered following an oil spill, and the return to pre-spill conditions may take many years. Opportunistic species are usually the first to occupy contaminated sediments, especially the polychaete, *Capitella capitata* (Sanders et al., 1980). Some polychaetes have been reported to have positive responses to oiling where they have greater densities at oiled sites compared with oil-free sites (Dean and Jewett, 2001). Concentrations as low as 10 ppm may alter benthic community structure (Gómez Gesteira and Dauvin, 2000).

An alteration in the benthic trophic structure may impact food availability for fish and invertebrates. Burrowing polychaetes and subsurface deposit feeders are not important in the diets of the red drum and spotted sea trout, two commercially and recreationally important species in the Gulf of Mexico (Gaston et al., 1998). Therefore, an increase in opportunistic species would result in less available food for certain species of fish (Gaston et al., 1998). The small surface-dwelling opportunistic species, however, appear to be important in the diet of juvenile brown shrimp (McTigue and Zimmerman, 1998) and therefore may provide additional food sources for this species. Early stage successional communities, however, cannot store and regulate the nutritional energy that a later stage community can because the organisms are small and remain at the sediment surface, resulting in a less stable and productive food source for higher trophic levels (Diaz and Solow, 1999).

Oil may be persistent when deposited in soft-bottom habitats, and biodegradation rates may be slower than those in coarser sediments (Dean and Jewett, 2001; Whittle et al., 1982). The oil at the surface may be weathered by bacteria, but the oil that is buried may remain unchanged for long periods of time because oxygen is required to weather oil, and lower sediment layers may be anoxic (Whittle et al., 1982; Ganning et al., 1984). Infaunal benthic species may be very sensitive to the persistent oil in benthic sediments that do not experience rapid biodegradation (Ganning et al., 1984). Oil that penetrates deep into the sediment can also cause anoxia and toxicity to the infaunal population as a result (Ganning et al., 1984). Minimum residence time for oil deposited in offshore sediments is estimated to be 3-4 years (Ganning et al., 1984; Moore, 1976).

Long-term or low-level exposure may also occur to benthic infauna exposed to oil adhered to sediment. Mesocosm experiments using long-term, low-level concentrations of No. 2 fuel oil indicate acute toxicity to meiofauna due to direct oil contact and sublethal effects from sedimented oil and byproducts of the decomposition of the sedimented oil (Frithsen et al., 1985). Long-term exposure to low levels of fuel oil was shown to affect recruitment success; meiofaunal population recovery took between 2 and 7 months (Frithsen et al., 1985). These types of impacts would be expected farther from the well where oil concentrations were diluted with distance.

Some oiled particles may become widely dispersed as they travel with currents while they settle out of suspension. Sedimented oil may travel great distances from the spill site and could be deposited 1-2 years following the spill (Suchanek, 1993). Settling rates are determined by size and weight of the particle, salinity, and turbulent mixing in the area (Poirier and Thiel, 1941; Bassin and Ichiye, 1977; Deleersnijder et al., 2006). Because particles would have different sinking rates, the oiled particles would be dispersed over a large area, most likely at sublethal or immeasurable levels. Studies conducted after the *Ixtoc* oil spill revealed that, although oil was measured on particles in the water column, measurable petroleum levels were not found in the underlying sediment (ERCO, 1982). Based on the settling rates and behavior of sedimented oil, the majority of organisms that may be exposed to sedimented oil are anticipated to experience low-level concentrations.

Research on oil spilled from the Chevron Main Pass Block 41C Platform into the Gulf of Mexico has indicated that oil in bottom sediments can weather rapidly, leaving only a small percentage of the oil in the sediments after a year (McAuliffe et al., 1975). Substantial weathering was noted 1 week and 1 month after the Chevron Main Pass spill and the oil remained in the top 1.5 in (3.8 cm) of the sediment. Benthic community fluctuations could not be correlated to the oil in the sediment from this oil spill and the numbers of brown and white shrimp and blue crabs in the area of the oil spill did not appear to decrease 3 months or 1 year after the spill (McAuliffe et al., 1975).

The toxicity of the oil is greatly reduced by the time it reaches the seafloor as a result of weathering in the water column (Ganning et al., 1984). The *Ixtoc* blowout flowed for 290 days and released approximately 475,000 metric tons of oil, which resulted in an estimated 120,000 metric tons of oil reaching the seafloor (Jernelöv and Lindén, 1981). Oil reached the seafloor in small droplets in the offshore waters, although some aggregates formed nearshore. The approximate concentration of oil on the seafloor was $1g/m^2$, which is not high enough to cause substantial damage to a benthic ecosystem (Jernelöv and Lindén, 1981). Surface sediment samples collected mid- and post-spill did not reveal any hydrocarbons from the *Ixtoc* spill; however, hydrocarbons from this source were identified on suspended sediment in the water column (ERCO, 1982). These data show that the oil may take some time to reach the seafloor and when it does, it is widely dispersed and weathered.

As with the Chevron Main Pass spill, depressions in the benthic community during and following the *Ixtoc* spill could not be linked to the oil because hydrocarbons from the blowout were not detected in sediment samples (ERCO, 1982). The benthic populations were depressed following the spill compared with pre-spill conditions; however, environmental evidence was not strong enough to separate oil impacts from natural variation or possible storm damage impacts (Tunnell et al., 1981). Oil may have been present in the sediment and affected benthic communities, but weathered before sampling occurred, or oil in the water column may have affected species, but these possible factors were not measured (Rabalais, 1990).

Field measurements after the *Ixtoc* blowout indicate that the concentrations of oil that reached the seafloor were low even after uncontrolled flow for a long period of time and that the oil was vastly dispersed by the time it reached the seafloor (ERCO, 1982). Inability to measure hydrocarbons in the sediment after the spill suggested that any oil that reached the seafloor had weathered rapidly. It is anticipated that similar dispersion of oil, rapid weathering, and resultant low-level, widespread concentrations of oil on the seafloor may result from similar blowouts.

Weathered oil is less toxic than freshly spilled oil because the remaining constituents are the larger, less bioavailable compounds (Ganning et al., 1984). The oil deposited on the seafloor is weathered from traveling in the water column and has lost a majority of its toxic compounds (Beiras and Saco-Álvarez, 2006). For example, amphipods, which are very sensitive to petroleum hydrocarbons, do not experience the level of toxicity when exposed to weathered oil that they do to fresh oil (Gómez Gesteira and Dauvin, 2000). Therefore, the majority of the oil that is on the seafloor would most likely result in sublethal impacts rather than acute toxicity, except for oil that may be rapidly deposited on the seafloor near the source of the spill.

Blowout and Sedimentation

Oil or gas well blowouts are possible occurrences in the OCS. Benthic communities exposed to large amounts of resuspended sediments following a subsurface blowout could be subject to sediment suffocation and exposure to toxic contaminants. Sediment deposition may smother benthic organisms, decreasing gas exchange, increasing exposure to anaerobic sediment, and causing physical abrasion (Wilber et al., 2005). Should oil or condensate be present in the blowout flow, liquid hydrocarbons could be an added source of negative impact on the benthos.

In rare cases, a portion or the entire rig may sink to the seafloor as a result of a blowout. The benthic communities on the seafloor upon which the rig settles would be destroyed or smothered. A settling rig may suspend sediments, which may smother nearby benthic communities as the sediment is redeposited on the seafloor. The habitats beneath the rig may be permanently lost; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The rig may add to the contaminants in the local area by leaking stores of fuel, oil, well treatment chemicals, and other toxic substances. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration.

Soft-bottom infaunal communities that are smothered or lost would be recolonized by populations from neighboring soft-bottom substrate. Recolonization would begin with the next recruitment cycle of the surrounding populations or from species immigration from surrounding stocks and may maintain a stronghold in the area until community succession begins (Rhodes and Germano, 1982; Sanders et al., 1980). Repopulation and succession in a disturbed bay off coastal Texas occurred within a year (Wilber et al., 2008).

Response Activity Impacts

Oil-spill-response activity may also affect sessile benthic communities. Continued localized disturbance of soft-bottom communities may occur during oil-spill-response efforts. Anchors used to set booms to contain oil or vessel anchors in decontamination zones may affect infaunal communities in the response activity zone. Infaunal communities may be altered in the anchor scar, and deposition of suspended sediment may result from setting and resetting of anchors. Anchors may also destroy submerged vegetation, altering benthic habitat (Dean and Jewett, 2001). The disturbed benthic community should begin to repopulate from the surrounding communities during their next recruitment event and through immigration of organisms from surrounding stocks. Any decontamination activities, such as cleaning vessel hulls of oil, may also contaminate the sediments of the decontamination zone, as some oil may settle to the seabed, impacting the underlying benthic community.

If a blowout occurs at the seafloor, drilling muds (primarily barite) may be pumped into a well in order to "kill" it. If a kill is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath heavy layers of the extruded drilling mud would be buried. Base fluids of drilling muds are designed to be low in toxicity and biodegradable in offshore marine sediments (Neff et al., 2000). However, as bacteria and fungi break down the drilling fluids, the sediments may be come anoxic (Neff et al., 2000). Benthic macrofaunal recovery would occur when drilling mud concentrations are reduced to levels that enable the sediment to become reoxygenated (Neff et al., 2000). Complete community recovery from drilling mud exposure may take 3-5 years, although microbial degradation of drilling fluids, followed by an influx of tolerant opportunistic species, is anticipated to begin almost immediately (Neff et al., 2000).

Proposed Action Analysis

Accidental releases of oil could occur as a result of a CPA proposed action. Small spills (0-1.0 bbl) would have the greatest number of occurrences (**Table 3-12**). Estimates of the number of small-scale releases as a result of a CPA proposed action ranges from 929 to 1,806 spills. These spills would be small in volume and rapidly diluted by surrounding water. A large-scale spill, ≥1,000 bbl, is very unlikely and, based on historical spill rates and projected production for a CPA proposed action, up to one spill of this volume in expected to occur as a result of a CPA proposed action. If a large-scale release of oil were to occur, impacts would be more widely spread. The likelihood of a catastrophic spill remains remote; however, the types and kinds of impacts to soft-bottom communities from such a low-probability catastrophic spill would likely be similar to those expected from a more typical accidental event at a community level.

The probability of surface water oiling occurring as a result of a CPA proposed action anywhere between the shoreline and the 300-m (984-ft) depth contour was estimated by the Bureau of Ocean Energy Management's OSRA model for spills ≥1,000 bbl. For surface waters of the LA West of Mississippi River polygon, the OSRA model estimated probabilities of 24-41 percent and 28-45 percent after 10 and 30 days, respectively, that a spill would occur and contact the region (**Figure 3-24**). For surface waters of the LA East of Mississippi River polygon, the OSRA model estimated probabilities of 4-8 percent and 5-9 percent for 10 and 30 days, respectively, that a spill would occur and contact the region (**Figure 3-24)**. For the Mississippi polygon, the OSRA model estimated probabilities of 3-6 percent and 4-8 percent for 10 and 30 days, respectively, that a spill would occur and contact the region (**Figure 3-24**). Finally, for the Alabama polygon, the OSRA model estimated probabilities of 2-5 percent and 4-7 percent after 10 and 30 days, respectively, that a spill would occur and contact the region (**Figure 3-24**).

Oil or dispersed oil may cause lethal or sublethal impacts to benthic organisms. Impacts may include loss of habitat and biodiversity, contamination of substrate, change in community structure, toxicity to larvae and embryos, and failed reproductive success. Oil adhered to sediment or sedimentation as a result of a blowout would impact benthic organisms, although the greatest impact would be to those organisms closest to the spill. Communities farther from the spill may experience low-level exposure and possibly sublethal impacts. It is important to note that soft sediments cover a majority of the seafloor of the Gulf of Mexico and any impacts incurred, even lethal exposures, would not impact the overall population of soft-bottom benthic organisms that inhabit the seafloor of the Gulf of Mexico. Any local communities that are lost would be repopulated fairly rapidly (Neff, 2005). Those communities that are continuously in an early successional stage would reach their previous community composition rapidly, in as little as 1 year (Gaston et al., 1998).

Summary and Conclusion

Because of the small amount of proportional space that OCS activities occupy on the seafloor, only a very small portion of the seafloor of the Gulf of Mexico would be expected to experience lethal impacts in an accidental event, as a result of blowouts, surface and subsurface oil spills, and their associated effects. The greatest impacts would be closest to the spill, and impacts would decrease with distance from the spill. Contact with spilled oil at a distance from the spill would likely cause sublethal to immeasurable effects to benthic organisms because the distance of activity would prevent contact with concentrated oil. Oil from a subsurface spill that reaches benthic communities would be primarily sublethal and impacts would be at the local community level. Any sedimentation and sedimented oil would also be at low concentrations by the time it reaches benthic communities far from the location of the spill, also resulting in sublethal impacts. Also, any local communities that are lost would be repopulated fairly rapidly (Neff, 2005). Although an oil spill may have some detrimental impacts, especially closest to the occurrence of the spill, the impacts may be no greater than natural biological fluctuations (Clark, 1982), and impacts would be to an extremely small portion of the overall Gulf of Mexico.

4.2.1.11.4. Cumulative Impacts

This cumulative analysis considers the effects of impact-producing factors related to soft bottoms of the Gulf of Mexico continental shelf. A CPA proposed action plus those actions related to prior and future OCS lease sales are considered; in this discussion, these are referred to as “OCS-related” factors. The vast majority of the Gulf of Mexico seabed is comprised of soft sediments and drilling is focused on these sediments, so the greatest number of OCS-related impacts occurs on soft-bottom benthic environments. Specific OCS-related, impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, blowouts, and operational discharges. Other non-OCS-related impacts that may occur and adversely affect soft-bottom benthic communities include commercial fisheries, natural disturbances, anchoring by recreational boats and other non-OCS commercial vessels, spillage from import tankering, cable laying, bottom trawling, hypoxia (low oxygen levels [2 ppm]), and storm events; all have the potential to damage soft-bottom benthic communities.

Most of the 268,922 km^2 (103,831 mi^2) of the CPA are soft mud bottoms and they are the substrate upon which well drilling occurs. It is important to note, however, that because the soft-bottom benthic communities comprise a majority of the seafloor of the Gulf of Mexico, impacts are not detrimental to the overall population of these habitats across the Gulf of Mexico. Also, because a large portion of the seafloor is subject to natural fluctuations and physical disturbances (such as storms and yearly hypoxic events), a permanent early successional community occupies much of the seafloor and enables rapid recovery of disturbed areas.

OCS Leasing-Related Impacts

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels are oil and gas OCS-related threats that disturb areas of the seafloor. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current (Lissner et al., 1991). Anchor damage could result in the crushing and smothering of infauna. Anchoring often destroys a wide swath of habitat by being dragged over the seafloor or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991).

Traditional pipeline-laying barges (as opposed to dynamically positioned barges) affect more seafloor than other anchoring impacts. These barges typically use an array of 8-12 anchors weighing about 4,500 kg (10,000 lb) each. While the large anchors crush organisms in their footprint, a much larger area is affected by anchor cable sweep as the barge is pulled forward to lay the pipeline by reeling-in forward cables and reeling-out aft cables. The anchors are reset repeatedly to forward positions to allow the barge to “crawl” forward. In this way, the anchor sweep scours parallel paths on each side of the vessel where the cables touch the seafloor. The width of the scoured paths varies with water depth (deeper water equals longer cables) and may be as much as 1,500 m (5,000 ft) to each side (only a portion of the cable adjacent to the anchor touches the seafloor). Damage to infauna as a result of anchoring may take approximately 1 year to recover, depending on the reproductive cycle and immigration of surrounding communities (Rhodes and Germano, 1982).

Another major impact of OCS-related construction is pipeline burial. In waters ≤60 m (200 ft), burial of pipelines is required. This involves trenching up to 3.3 m (10 ft) deep in the seafloor from a water depth of ≤60 m (200 ft) to shore. This is a severe disturbance of the trenched area and creates a large turbidity plume. Resuspended sediments can cause obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to areas in the vicinity of the barge. Impacts may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA. L.P., 2003).

Both explosive and nonexplosive structure-removal operations disturb the seafloor; however, they are not expected to affect soft-bottom communities because many sessile benthic organisms are known to resist the concussive force of structure-removal-type blasts (O'Keeffe and Young, 1984). O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods" as a result of experiments with explosives. Impacts to invertebrates are anticipated to be minimal as they do not have air bladders inside their bodies that may burst with explosions, as some fish do (Schroeder and Love, 2004).

Routine discharges of drilling muds and cuttings by oil and gas operations could affect biological communities and organisms through a variety of mechanisms, including the smothering of organisms through deposition or less obvious sublethal effects (impacts to growth and reproduction). Smothering of infauna by drilling discharges may be one of the greatest impacts to localized communities near a well, especially one that has shunted its cuttings to the seafloor to protect nearby topographic features. The heaviest concentrations of well cuttings and drilling fluids, for both water-based and synthetic-based drilling muds, have been reported within 100 m (328 ft) of wells and are shown to decrease beyond that distance (CSA, 2004b; Kennicutt et al., 1996). Although impacts are locally drastic, cumulative impacts over the seafloor of the Gulf of Mexico are anticipated to be very small, as such comparatively small areas are affected.

Produced waters from petroleum operations are not likely to have a great impact on soft-bottom communities. Produced waters are rapidly diluted, impacts are generally only observed within proximity of the discharge point, and acute toxicity that may result from produced waters occurs "within the immediate mixing zone around a production platform" (Gittings et al., 1992b; Holdway, 2002). Impacts to sediment and marine organisms are generally reported within a 100-m (328-ft) range of the produced-water discharge (Neff and Sauer, 1991; Trefry et al., 1995). Also, USEPA's general NPDES permit restrictions on the discharge of produced water, which require the effluent concentration 100 m (328 ft) from the outfall to be less than the 7-day no observable effect concentration based on laboratory exposures (Smith et al., 1994). Therefore, impacts to infauna are anticipated to be localized and to only affect a small portion of the entire seafloor of the Gulf of Mexico.

Oil spills may have an impact on the benthic communities of the Gulf of Mexico. Surface oil spills released from tankers may impact shallow, nearshore benthic communities through physical contact. Surface oil slicks released offshore can be moved toward shore by winds, but oil mixed into the water column is moved by water currents, which do not generally travel toward shore (Pond and Pickard, 1983; Inoue et al., 2008). Disturbance of the sea surface by storms can mix surface oil 10-20 m (33-66 ft) into the water column (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). This may result in direct oil contact or exposure to water soluble fractions for shallow, nearshore benthic communities, resulting in lethal impacts to organisms (Suchanek, 1993; Beiras and Saco-Álvarez, 2006; Byrne, 1989) or impaired embryonic development (Byrne and Calder, 1977; Nicol et al., 1977; Vashchenko, 1980). If such events were to occur, recovery to pre-impact conditions could take approximately a year (Lu and Wu, 2006; Neff, 2005), with the overall recovery time depending on the extent of oiling, presence of recolonizers nearby, time of year for reproduction of those colonizers, currents and water circulation patterns, and the ability of the recolonizers to tolerate the sediment conditions (Ganning et al., 1984). Recovery of benthic populations in soft subtidal environments, however, have been reported to take up to 5-10 years after oiling (Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000). Benthic communities farther offshore, in deeper water, however, would be protected from direct physical contact of surface oil by depth below the sea surface. Any dispersed surface oil from a tanker or rig spill that may reach the benthic communities on the seafloor of the Gulf of Mexico at a depth greater than 10 m (33 ft) would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations may not be life threatening to adult stages, but they may harm larval or embryonic life stages of benthic organisms (Fucik et al., 1995; Suchanek, 1993; Beiras and Saco-Álvarez, 2006; Byrne, 1989).

Potential blowouts may impact the biota of the soft-bottom benthic communities. If any blowouts from wells occur, the suspended sediments should settle out of the water column fairly quickly, locally smothering benthic organisms near the well. Any oil that becomes entrained in a subsurface plume would be dispersed as it travels in the water column (Vandermuelen, 1982; Tkalich and Chan, 2002). Subsea oil plumes near the seafloor would pass over smooth soft bottom, continuing the processes of diffusion and biodegradation. These plumes would continue to be dispersed over a wide area in low concentrations with sublethal to immeasurable effect. If concentrated oil were to contact the soft-bottom communities directly, the impacts may include lethal effects with loss of habitat and biodiversity, contamination of substrate, change in community structure, and failed reproductive success. Damage to infauna as a result of subsurface plume exposure may take approximately 1 year to recover, depending on the reproductive cycle and immigration of surrounding communities (Rhodes and Germano, 1982).

In November 2010, it was estimated that 26 percent of the released oil from the DWH event remained in the environment as oil on or just below the water surface as a light sheen or tarballs, oil that was washed ashore or collected from the shore, and oil that was in the sediments (Lubchenco et al., 2010). Currently, the bulk deposits of oil have been removed from beaches, and the remaining oil that reached shorelines has been buried (e.g., through wave action and hurricanes) and is weathering over time (OSAT-2, 2011). Oil that has been deposited on the floor of the Gulf has also weathered (OSAT, 2010). The greatest concentrations of oil on the seabed are expected to be near the wellhead and to decrease with distance from the source. The modes of transport to the seafloor discussed below are anticipated to only deliver a small amount of oil to the seafloor with decreasing concentrations from the well. Evidence shows that gas and oil from the DWH event in the water column rapidly deteriorated as they traveled to their final destination (Hazen et al., 2010; OSAT, 2010).

A recent report documents damage to a deepwater coral community 11 km (7 mi) southwest of the blowout (USDOI, BOEMRE, 2010j). Soft bottoms in this area were also likely exposed to oil, but sediment cores collected from this location did not contain levels of oil that exceeded the USEPA aquatic life benchmarks (OSAT, 2010). A probable explanation for the detrimental impacts to corals, in the absence of USEPA aquatic life benchmark exceedances, is that the coral community forms structures that protrude up into the water column that would be affected by a passing oil plume in a way that a typical smooth soft bottom would not because infaunal species remain below the sediment. The oil plume probably passed over smooth soft bottom, continuing the process of biodegradation in mid-water and continuing to be dispersed over a wide area.

The cumulative impact to soft bottoms of possible future oil spills, along with the DWH event, is anticipated to be small. The limited data currently available on the impacts of the DWH event make it difficult to define impacts to the soft-bottom communities in the CPA. It appears some impacts have occurred to corals within 7 mi (11 km) of the well, and it is anticipated that the soft-bottom communities in the area were impacted as well but with a lower impact because smooth, flat seafloor would allow the oil plume to pass unimpeded. Water column sampling, however, indicated that concentrations of total petroleum hydrocarbons in the water column were less than 0.5 ppm, 40 and 45 nmi (74 and 83 km; 46 and 52 mi) northeast of the well (Haddad and Murawski, 2010). Also, seafloor samples indicated that the only sediment exceedances of the USEPA's chronic aquatic life benchmarks occurred within 3 km (2 mi) of the well, and samples fell to background levels at a distance of 10 km (6 mi) from the well (OSAT, 2010). Therefore, the acute impacts of any large-scale blowout to soft-bottom benthic communities would likely be limited in scale and influenced by directional currents and any additive impacts of several blowouts should have acute effects in only small areas, with possible sublethal impacts occurring over a larger area. However, the locally impacted seafloor would be very small compared with the overall size of the seafloor of the CPA (268,922 km^2; 103,831 mi^2) and would not impact the overall infaunal population.

Non-OCS Leasing Impacts

Severe physical damage may occur to soft-bottom sediments and the associated benthic communities as a result of non-OCS activities. Infauna associated with soft-bottom sediments of the CPA are often exposed to, and can be well adapted to, natural disturbances such as turbidity and storms. However, human disturbance, such as trawling or non-OCS activity related oil spills, may cause damage to infauna, possibly leading to changes of physical integrity, species diversity, or biological productivity. However, because some benthic communities in the northern Gulf of Mexico are permanently in early community successional stages due to frequent disturbances, full recovery may occur very quickly (Rabalais et al., 2002a; Gaston et al., 1998; Diaz and Solow, 1999).

Non-OCS activities have a greater potential to affect the soft-bottom communities of the region than BOEM-regulated activities. Natural events such as storms, extreme weather, and fluctuations of environmental conditions may impact soft-bottom infaunal communities. Soft-bottom communities occur from the shoreline into the deep waters of the Gulf of Mexico. Storms can physically affect shallow bottom environments, causing an increase in sedimentation, burial of organisms by sediment, a rapid change in salinity or dissolved oxygen levels, storm surge scouring, remobilization of contaminants in the sediment, and abrasion and clogging of gills as a result of turbidity (Engle et al., 2008). Storms have also been shown to uproot benthic organisms from the sediment and suspend organisms in the water column (Dobbs and Vozarik, 1983). Large storms may devastate infaunal populations; for example, 2 months after Hurricane Katrina a significant decrease in the number of species, species diversity, and species density occurred in coastal waters off Louisiana, Mississippi, and Alabama (Engle et al., 2008). Such impacts may be devastating to a benthic community.

Hypoxic conditions of inconsistent intensities and ranges also occur annually in a band that stretches along the Louisiana-Texas shelf each summer (Rabalais et al., 2002a). The dissolved oxygen levels in the Gulf of Mexico hypoxic zone are less than 2 ppm. Such low concentrations are lethal to many benthic organisms and may result in the loss of some benthic populations. However, because the Gulf of Mexico's soft-bottom benthic habitats are ubiquitous throughout the Gulf, recolonization of devastated areas by populations from unaffected soft-bottom substrate would be expected to occur within a relatively short period of time, once the hypoxic event is over, through planktonic larval dispersal in the water column (Dubois et al., 2009; Thistle, 1981).

Recreational boating, fishing, and import tankering may have limited impact on soft-bottom communities. Ships anchoring near major shipping fairways of the CPA or recreational fishing boats setting anchor would impact bottom habitats. Anchor placement may crush and eliminate infauna in the footprint of the anchor.

Damage resulting from commercial fishing, especially bottom trawling, may have a severe impact on soft-bottom benthic communities. Bottom trawling in the Gulf of Mexico primarily targets shrimp from nearshore waters to depths of approximately 90 m (295 ft) (NRC, 2002), which are the depths where the greatest trawling impacts are anticipated. Studies have indicated that trawled seafloor has reduced species diversity compared with untrawled seafloor (McConnaughey et al., 2000). Trawl trails may scour sediment, killing infauna, and epifaunal organisms may be physically removed (Engel and Kvitek, 1998). Trawling also contributes regularly to turbidity, as nets drag the seafloor, leaving trails of suspended sediment. Repetitive disturbance by trawling activity may lead to a community dominated by opportunistic species (Engel and Kvitek, 1998). Recovery from the passing of a trawl net would begin to occur with the following reproduction cycle of surrounding benthic communities (Rhodes and Germano, 1982), but populations may be severely impacted by repetitive trawling activity (Engel and Kvitek, 1998).

Summary and Conclusion

Non-OCS activities that may occur on soft-bottom benthic substrate include recreational boating and fishing, import tankering, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions. These activities could cause temporary damage to soft-bottom communities. Ships and fishermen anchoring on soft bottoms may crush and smother underlying organisms. Oil spills from non-OCS import tankering or other activity may result in oiled benthic communities that would only repopulate once the concentration of oil in the sediment has decreased. During severe storms, such as hurricanes, large waves may stir bottom sediments, which cause scouring, remobilization of contaminants in the sediment, abrasion and clogging of gills as a result of turbidity, uprooting benthic organisms from the sediment, and an overall result in decreased species diversity (Engle et al., 2008; Dobbs and Vozarik, 1983). Yearly hypoxic events may eliminate many species from benthic populations over a wide area covering most of the CPA and part of the WPA continental shelf (Rabalais et al., 2002a).

Impacts from routine activities of OCS oil and gas operations include anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, and discharges of produced waters. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to infaunal communities. Long-term OCS activities are not expected to adversely impact the entire soft-bottom environment because the local impacted areas are extremely small compared with the entire seafloor of the Gulf of Mexico and because impacted communities are repopulated relatively quickly. Also, USEPA's general NPDES permit restrictions on the discharge of produced water, which require the effluent concentration 100 m (328 ft) from the outfall to be less than the 7-day no observable effect concentration based on laboratory exposures, would help to limit the impacts on benthic communities (Smith et al., 1994).

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals may have local devastating impacts but the cumulative effect on the overall seafloor and infaunal communities on the Gulf of Mexico would be very small. Soft-bottom benthic communities are ubiquitous throughout and often remain in an early successional stage due to natural fluctuation, and therefore, the activities of OCS production of oil and gas would not cause additional severe cumulative impacts.

The incremental contribution of a CPA proposed action to the cumulative impact is expected to be slight, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Non-OCS factors, such as storms, trawling, non-OCS-related spills, and hypoxia, are likely to impact the soft-bottom communities on a more frequent basis. Impacts from OCS activities are also somewhat minimized by the fact that these communities are ubiquitous through the WPA and can recruit quickly from neighboring areas.

4.2.1.12. Marine Mammals

4.2.1.12.1. Description of the Affected Environment

The U.S. Gulf of Mexico marine mammal community is diverse and distributed throughout the northern Gulf waters. Twenty-one species of cetaceans regularly occur in the Gulf of Mexico (Jefferson et al., 1992; Davis et al., 2000) and are identified in the NMFS Gulf of Mexico Stock Assessment Reports (Waring et al., 2011) in addition to one species of Sirenian. The Gulf of Mexico's marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales), as well as the order Sirenia, which includes the manatee and dugong. Most GOM cetacean species have worldwide distributions; however, two exceptions are Atlantic spotted dolphins (*Stenella frontalis*) and clymene dolphins (*Stenella clymene*). Common in the Gulf, these two species are found only in the Atlantic Ocean and its associated waters.

There are species that have been reported from Gulf waters, either by sighting or stranding, that, due to their rarity, are not considered in this EIS (Wursig et al. 2000; Mullin and Fulling 2004). These species include the blue whale (*Balaenoptera musculus*), the northern right whale (*Eubalaena glacialis*), and the Sowerby's beaked whale (*Mesoplodon bidens*), all considered extralimital in the Gulf of Mexico, and the humpback whale (*Megaptera novaeangliae*), the fin whale (*Balaenoptera physalus*), the sei whale (*Balaenoptera borealis*), and the minke whale (*Balaenoptera acutorostrata*), all considered rare occasional migrants in the Gulf (Wursig et al., 2000; Mullin and Fuling, 2004). Because these species are uncommon in the GOM (and by extension the CPA), they are not included in the most recent NMFS Gulf of Mexico Stock Assessment Reports (Waring et al., 2011).

Threatened or Endangered Species

There is only one cetacean, the sperm whale (*Physeter macrocephalus*), and one sirenian, the West Indian manatee (*Trichechus manatus*), that regularly occur in the GOM and that are listed as endangered under the Endangered Species Act (ESA). The sperm whale is common in oceanic waters of the northern GOM and appears to be a resident species. The West Indian manatee (*Trichechus manatus*) typically inhabits only coastal marine, brackish, and freshwater areas.

Cetaceans—Odontocetes

The sperm whale is found worldwide in deep waters between approximately 60 °N. and 60 °S. latitude (Whitehead, 2002), although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al., 1993). As deep divers, sperm whales generally inhabit oceanic waters, but they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al., 1993). Sperm whales prey on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson et al., 1993).

The sperm whale is the only great whale that is considered common in the northern GOM (Fritts et al., 1983a; Mullin et al., 1991; Davis and Fargion, 1996; Jefferson and Schiro, 1997). Aggregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River Delta in waters that are 500-2,000 m (1,641-6,562 ft) in depth (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). They are often concentrated along the continental slope in or near cyclones and zones of confluence between cyclones and anticyclones (Davis et al., 2000). Consistent sightings and satellite tracking results indicate that sperm whales occupy the northern GOM throughout all seasons (Mullin et al., 1994; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000; Jochens et al. 2008). For management purposes, sperm whales in the GOM are considered a separate stock from those in the Atlantic and Caribbean (Englehaupt et al. 2009, Gero et al. 2007, Jacquet 2006, Jochens et al., 2008). The best abundance estimate available for sperm whales in the northern GOM is 1,665 individuals (Waring et al., 2011).

Life History

Females and juveniles form pods that are restricted mainly to tropical and temperate latitudes (between 50 °N. and 50 °S. latitude), while the solitary adult males can be found at higher latitudes (between 75 °N. and 75 °S. latitude) (Reeves and Whitehead, 1997). In the western North Atlantic, they range from Greenland to the GOM and the Caribbean.

Evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce vocalizations (Norris and Harvey, 1972; Cranford, 1992). This suggests that vocalizations are extremely important to sperm whales. The function of vocalizations is relatively well-studied (Weilgart and Whitehead, 1997; Goold and Jones, 1995). Long series of monotonous, regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Sperm whales also use unique stereotyped click sequence “codas” (Mullins et al., 1988; Watkins and Scheville, 1977; Watkins et al., 1985), according to Weilgart and Whitehead (1988), to possibly convey information about the age, sex, and reproductive status of the sender. Groups of closely related females and their offspring have group-specific dialects (Weilgart and Whitehead, 1997).

Sperm whales generally occur in water depths greater than 180 m (591 ft). While they may be encountered almost anywhere on the high seas, their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves, 1983). Waring et al. (1993) suggest sperm whale distribution in the Atlantic is closely correlated with the Gulf Stream edge. Bull sperm whales migrate much farther poleward than the cows, calves, and young males. Because most of the breeding herds are confined almost exclusively to warmer waters, many of the larger mature males return in the winter to the lower latitudes to breed. It is not known whether Gulf sperm whales exhibit similar seasonal movement patterns; research to date does not support such seasonal movement patterns. Sperm whale presence in the Gulf is year-round; however, because of the lack of adult males observed in the GOM, it is not known whether females leave the area to mate or whether males sporadically enter the area to mate with females. However, recent tag data indicate that this group offshore of the Mississippi River Delta remains in the northern Gulf area year-round and represents a resident population (Jochens et al., 2008). Davis et al. (2000 and 2002) reported that low-salinity, nutrient-rich water may occur over the continental slope near the mouth of the Mississippi River or be entrained within the confluence of a cyclone-anticyclone eddy pair and transported over the narrow continental shelf south of the Mississippi River Delta. This creates an area of high primary and secondary productivity in deep water that may explain the presence of the resident population of endangered sperm whales within 100 km (62 mi) of the Mississippi River Delta (Davis and Fargion, 1996; Davis et al., 2000; Weller et al., 2000).

Deep water is their typical habitat, but sperm whales also occur in coastal waters at times (Scott and Sadove, 1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply, and with the movement of cyclonic eddies in the northern Gulf (Davis et al., 2000 and 2002). Although sperm whales have been sighted throughout the GOM, sperm whales south of the Mississippi River Delta apparently concentrate their movements to stay in or near variable areas of upwelling, or cold-core rings (Würsig et al., 2000; Davis et al., 2002; Jochens et al. 2008). Presumably this is because of the greater productivity inherent in such areas, which would provide concentrated sources of forage species for these whales. The continental margin in the north-central Gulf is only 20 km (12 mi) wide at its narrowest point, and the ocean floor descends quickly along the continental slope, reaching a depth of 1,000 m (3,281 ft) within 40 km (25 mi) of the coast. This unique area of the GOM brings deepwater organisms within the influence of coastal fisheries, contaminants, and other human impacts on the entire northern Gulf. Low salinity, nutrient-rich water from the Mississippi River contributes to enhanced primary and secondary productivity in the north-central Gulf and may explain the presence of sperm whales in the area (Davis et al., 2000).

Sperm whales are noted for their ability to make prolonged, deep dives, and are likely the deepest and longest diving mammal. Typical foraging dives last 40 minutes and descend to about 400 m (1,312 ft), followed by approximately 8 minutes of resting at the surface (Gordon, 1987; Papastavrou et al., 1989). However, dives of over 2 hours and deeper than 3.3 km (2.1 mi) have been recorded (Clarke, 1976; Watkins et al., 1985; Watkins et al., 1993) and individuals may spend extended periods of time at the surface to recover. Descent rates recorded from echo-sounders were approximately 1.7 m/sec (5.6 ft/sec) and nearly vertical (Goold and Jones, 1995). There are no data on diurnal differences in dive depths in sperm whales. Dive depth may be dependent upon temporal variations in prey abundance. Palka and Johnson (2007) present the results of a study that collected the dive patterns of sperm whales in the Atlantic Ocean to compare them with the dive patterns and social structure of sperm whales in the Gulf of Mexico. The study started a baseline of line transect, photo-identification, oceanographic, and genetic data for the Atlantic sperm whale. Compared with the Mississippi River Delta in the Gulf of Mexico, parts of the Atlantic Ocean may serve as a control population of sperm whales with little exposure to sounds of oil- and gas-related activities. The study found that Gulf of Mexico sperm whales follow a foraging and socializing cycle similar to that seen for the North Atlantic whales, but North Atlantic sperm whales dive significantly deeper (average 934 m [3,064 ft] compared with 639 m [2,096 ft] for Gulf of Mexico whales) when foraging.

Cephalopods (i.e., squid, octopi, cuttlefishes, and nautilus) are the main dietary component of sperm whales. The ommastrephids, onychoteuthids, cranchids, and enoploteuthids are the cephalopod families that are numerically important in the diet of sperm whales in the GOM (Davis et al., 2002). Other populations are known to also take significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes, especially mature males in higher latitudes (Clarke, 1962 and 1979). Postulated feeding and hunting methods include lying suspended and relatively motionless near the ocean floor and ambushing prey, attracting squid and other prey with bioluminescent mouths, or stunning prey with ultrasonic sounds (Norris and Mohl, 1983; Würsig et al., 2000). Sperm whales occasionally drown after becoming entangled in deep-sea cables that wrap around their lower jaw, and non-food objects have been found in their stomachs, suggesting these animals may at times cruise the ocean floor with open mouths (Würsig et al., 2000; Rice, 1989).

Population Dynamics

There is evidence based on the year-round occurrence of strandings, opportunistic sightings, whaling catches, and recent sperm whale research and survey data that sperm whales in the GOM may be found throughout deep waters of the GOM (Schmidley, 1981; Hansen et al., 1996; Davis et al., 2002; Mullin and Fulling, 2004; Jochens et al. 2008). The NMFS treats sperm whales in the GOM as a distinct stock in the Marine Mammal Stock Assessment Report (Waring et al., 2011), and recent research supports this (Englehaupt et al., 2009). Seasonal aerial surveys have confirmed that sperm whales are present in the northern GOM in all seasons. Sightings are more common during summer (Mullin et al., 1991; Mullin et al., 1994a; Mullin and Hoggard, 2000; Mullin and Fulling, 2004), but this may be an artifact of movement patterns of sperm whales associated with reproductive behavior, hydrographic features, or other environmental and seasonal factors.

Female sperm whales attain sexual maturity at the mean age of 8 or 9 years and a length of about 9 m (30 ft) (Kasuya, 1991; Würsig et al., 2000). The mature females ovulate April through August in the Northern Hemisphere. During this season, one or more large mature bulls temporarily join each breeding school. A single calf is born at a length of about 4 m (13 ft), after a 15- to 16-month gestation period. Sperm whales exhibit alloparental (assistance by individuals other than the parents in the care of offspring) guarding of young at the surface (Whitehead, 1996) and alloparental nursing (Reeves and Whitehead, 1997). Calves are nursed for 2-3 years (in some cases, up to 13 years), and the calving interval is estimated to be about 4-7 years (Kasuya, 1991; Würsig et al., 2000).

Males have a prolonged puberty and attain sexual maturity at between 12 and 20 years, and have a body length of 12 m (39 ft); however, they may require another 10 years to become large enough to successfully compete for breeding rights (Kasuya, 1991; Würsig et al., 2000). Bachelor schools consist of maturing males who leave the breeding school and aggregate in loose groups of about 40 animals. As the males grow older, they separate from the bachelor schools and remain solitary most of the year (Best, 1979).

The age distribution of the GOM sperm whale population is unknown, but they are believed to live at least 60 years. Potential sources of natural mortality in sperm whales include killer whales and the papilloma virus (Lambertsen et al., 1987). Little is known of recruitment and mortality rates; however, recent abundance estimates based on surveys indicate that the population appears to be stable, but NMFS believes there are insufficient data to determine population trends in the GOM for this species at this time (Waring et al., 2011).

Status and Distribution

Sperm whales are found throughout the world's oceans in deep waters between about 60° N. and 60° S. latitude (Leatherwood and Reeves, 1983; Rice, 1989). The primary factor for the population decline that precipitated ESA listing was commercial whaling in the 18th, 19th, and 20th centuries for ambergris and spermaceti. The International Whaling Commission (IWC) estimates that nearly 250,000 sperm whales were killed worldwide in whaling activities between 1800 and 1900. A commercial fishery for sperm whales operated in the GOM during the late 1700's to the early 1900's, but the exact number of whales taken is not known (Townsend, 1935). The overharvest of sperm whales resulted in their alarming decline in the last century. From 1910 to 1982, there were nearly 700,000 sperm whales killed worldwide from whaling activities (IWC Statistics, 1959-1983) (USDOC, NMFS, 2002). Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead, 1997). Since the ban on nearly all hunting of sperm whales, there has been little evidence that direct effects of anthropogenic causes of mortality or injury are significantly affecting the recovery of sperm whale stocks (Perry et al., 1999), yet the effects of these activities on the behavior of sperm whales has just recently begun to be studied. Sperm whales are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. As of 2002, the global population of sperm whales is estimated to be at 32 percent of its pre-whaling number (Whitehead, 2002).

Since sperm whales were listed under the ESA, a concern for the effects of anthropogenic activities on the physiology and behavior of marine mammals has received much attention. Sperm whales have been identified as species of concern in the GOM in relation to shipping, seismic surveys, and energy production (Jasny, 1999), although the studies of the effects of seismic surveys on sperm whales have been relatively few and have been largely inconclusive. The debate on the biological significance of certain reactions, or no reaction at all, makes any results difficult and sometimes contentious to interpret. However, many reported reactions to anthropogenic noise deserve special attention in assessing impacts to sperm whales and marine life in general. Sperm whale vocalization and audition are important for echolocation and feeding, social behavior and intragroup interactions, and maintaining social cohesion within the group. Anthropogenic sources from vessel noise, noise associated with oil production, seismic surveys, and other sources have the potential to impact sperm whales (e.g., behavioral alteration, communication, feeding ability, disruption of breeding and nursing, and avoidance of locales where audible sounds are being emitted).

Andrew et al. (2002) reported that, over a 33-year period, increases in shipping sound levels in the ocean may account for a 10-dB increase in ambient noise between 20 and 80 Hz and between 200 and 300 Hz, and a 3-dB increase in noise at 100 Hz on the continental slope off Point Sur, California.

Although comparable data are not available for the GOM, it is likely that similar ambient noise increases have occurred. Much of the change is expected to be attributable to commercial shipping (greater numbers of ships in the Gulf and larger ship size are both factors). However, the expansion of oil and gas industry activities, including more structures, more exploration (seismic surveys) and drilling, a larger service boat fleet, and much greater distances to travel to deepwater installations, has also contributed to more sound in Gulf waters.

Documented takes of sperm whales primarily involve offshore fisheries such as the offshore lobster pot fishery and pelagic driftnet and longline fisheries. However there has been no reported fishing-related mortality in the Gulf of Mexico during the years 1998-2008; however, there was one sperm whale released alive in 2008 after an entanglement interaction with the pelagic longline fishery (Waring et al., 2011). Sperm whales have learned to depredate sablefish from longline gear in the Gulf of Alaska (Thode et al., 2007) and toothfish from longline operations in the south Atlantic Ocean. No direct injury or mortality has been recorded during hauling operations, but lines have had to be cut when whales were caught on them (Ashford et al., 1996). Because of their generally more offshore distribution and their benthic feeding habits, sperm whales are less subject to entanglement than are right or humpback whales. Sperm whales have been taken in the pelagic drift gillnet fishery for swordfish and could likewise be taken in the shark drift gillnet fishery on occasions when they may occur more nearshore, although this likely does not occur often. Although no interaction between sperm whales and the longline fishery have been recorded in the U.S. Atlantic, as noted above, such interactions have been documented elsewhere. The Southeast U.S. Marine Mammal Stranding Network documented three strandings in 2008 (1 in Florida and 2 in Texas), two strandings in 2007 (1 in Texas and 1 in Florida) and none in 2004-2006 (Waring et al., 2011). No evidence of human interactions was detected for these strandings.

The NMFS recently published a final recovery plan for the sperm whale (USDOC, NMFS, 2010b), and current threats to sperm whale populations worldwide are discussed. Threats are defined as “any factor that could represent an impediment to recovery” and include fisheries interactions, anthropogenic noise, vessel interactions, contaminants and pollutants, disease, injury from marine debris, research, predation and natural mortality, direct harvest, competition for resources, loss of prey base due to climate change and ecosystem change, and cable laying. In the GOM, the impacts from many of these threats are identified as either low or unknown (Waring et al. 2011). For example, The Recovery Plan states that the impacts from fisheries are low since sperm whales may break through fishing gear. However, they may die later as a result of the entanglement, but the death would go unreported. Further, it states, “During 2001-2005, human-caused mortality was estimated at 0.2 sperm whales per year (0.0 sperm whales per year from fisheries and 0.2 from ship strikes) off the east coast of the U.S.” (Waring et al., 2011). In regards to the effects of anthropogenic noise, the Recovery Plan states that it is “difficult to ascertain and research on this topic is ongoing.” The possible impacts of the various sources of anthropogenic noise, which is described below, have not been well studied on sperm whales. The threat occurs at an unknown severity, and there is a high level of uncertainty associated with the evidence described below. Thus, the relative impact of anthropogenic noise to the recovery of sperm whales is ranked as “unknown.”

Recent Research

Since the previous 2007-2012 Multisale EIS consultation (USDOI, MMS, 2007c) and Biological Opinion from NMFS (USDOC, NMFS, 2007b), this Agency has completed the Sperm Whale Seismic Study, and a synthesis report was published in 2008 (Jochens et al., 2008). The principle conclusions from this multiyear research effort were as follows:

(1) the data support the conservation of sperm whales in the northern Gulf of Mexico as a discrete stock;

(2) sperm whales are present year-round in the Gulf, with females generally having significant site fidelity and with males and females exhibiting significant differences in habitat usage;

(3) the sperm whale population off the Mississippi River Delta likely has a core size of about 140 individuals;

(4) Gulf sperm whales seem to be smaller in individual size than sperm whales in some other oceans;

(5) some groups of sperm whales in the Gulf were mixed-sex groups of females/immatures and others were groups of bachelor males; typical group size for mixed groups was 10 individuals, which is smaller than group sizes in some other oceans;

(6) the typical diving and underwater behaviors of the Gulf's sperm whales are similar to those of animals in other oceans;

(7) the typical feeding and foraging behaviors of the Gulf's sperm whales are similar to those of animals in other oceans, although differences in defecation rates suggest possible differences in feeding success;

(8) in the otherwise oligotrophic Gulf of Mexico, the eddy field contributes to development of regions of locally high surface productivity that in turn may create conditions favorable for trophic cascade of surface production to the depths where Gulf sperm whales dive to forage;

(9) there appeared to be no horizontal avoidance to controlled exposure of seismic airgun sounds by sperm whales in the main Sperm Whale Seismic Study area;

(10) data analysis suggests it is more likely than not that some decrease in foraging effort may occur during exposure to full-array airgun firing as compared with the post-exposure condition, at least for some individuals; and

(11) knowledge of the acoustic propagation and airgun sound characteristics is critical to developing the capability for accurate predictions of exposures and the modeling of potential resulting effects.

Recommendations from the Sperm Whale Seismic Study included continued conservation of GOM sperm whales as a separate stock, implementation of a long-term monitoring program, continued controlled exposure experiments, investigation into sperm whale prey fields, continued development of tagging sensor and instrument capabilities, and continued development of passive acoustic monitoring techniques.

In 2009, this Agency entered into an Interagency Agreement with NMFS's Southeast Fisheries Science Center for the Sperm Whale Acoustic Prey Study. Study objectives include quantitative sampling of the mid-water pelagic community within the foraging depths of sperm whales, examination of the relationships between acoustic backscatter and prey taxonomic composition, and comparison of sperm whale distribution and prey composition across habitats of the northern GOM. Field work is complete and sample analyses and data synthesis are ongoing.

Sirenians

The West Indian manatee (*Trichechus manatus*) is the only sirenian occurring in tropical and subtropical coastal waters of the southeastern U.S., the GOM, and the Caribbean Sea (Jefferson et al., 1993; O'Shea et al., 1995). There are two subspecies of the West Indian manatee: the Florida manatee (*T. m. latirostris*), which ranges from the northern GOM to Virginia; and the Antillean manatee (*T. m. manatus*), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea.

Manatees are generalist feeders and are known to consume more than 60 species of aquatic vegetation in marine, estuarine, and freshwater habitats (USDOI, FWS, 2001). Manatees primarily use open coastal (shallow nearshore) areas and estuaries, and they are also found far up in freshwater tributaries. Shallow grassbeds with access to deep channels are their preferred feeding areas in coastal and riverine habitats (near the mouths of coastal rivers), and sloughs are used for feeding, resting, mating, and calving (USDOI, FWS, 2001).

Florida manatees have been divided into four distinct regional management units: the Atlantic Coast Unit that occupies the east coast of Florida, including the Florida Keys and the lower St. Johns River north of Palatka, Florida; the Southwest Unit that occurs from Pasco County, Florida, south to Whitewater Bay in Monroe County, Florida; the Upper St. Johns River Unit that occurs in the river south of Palatka, Florida; and the Northwest Unit that occupies the Florida Panhandle south to Hernando County, Florida (Waring et al., 2011). Manatees from the Northwest Unit are more likely to be seen in the northern GOM, and they can be found as far west as Texas; however, most sightings are in the eastern GOM (Fertl et al., 2005).

During warmer months (June to September), manatees are common along the Gulf Coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida. Although manatees are less common farther westward, manatee sightings increase during the warmer summer months. Winter habitat use is primarily influenced by water temperature as animals congregate at natural (springs) and/or artificial (power plant outflows) warm water sources (Alves-Stanley et al. 2010).

The best available count of Florida manatees is 4,834 animals, based on a January 2011 aerial survey of warm water refuges (Florida Fish and Wildlife Conservation, Fish and Wildlife Research Institute, 2011a). In 2010, of the 767 manatee carcasses collected in Florida, 88 of these animals died of human causes (Florida Fish and Wildlife Conservation, Fish and Wildlife Research Institute, 2010a). Human causes included water control structures, entanglement in and ingestion of marine debris, entrapment in pipes/culverts and collisions with watercraft. Ninety-four percent of manatees that died of human causes were killed by watercraft (Florida Fish and Wildlife Conservation, Fish and Wildlife Research Institute, 2010a).

Recent Section 7 Endangered Species Act Consultation

As mandated by the Endangered Species Act, BOEM consults with NMFS and FWS on possible and potential impacts from BOEM's proposed actions on endangered/threatened species and designated critical habitat under their jurisdiction. Prior consultation with NMFS and FWS on the previous 2007-2012 Multisale EIS was completed in 2007 (USDOI, MMS, 2007c). Following the DWH event on July 30, 2010, BOEMRE requested reinitiation of the previous ESA consultation with both NMFS and FWS. The BOEM is developing a more programmatic approach with NMFS and FWS for future ESA consultations; this approach will evaluate BOEM activities on a more programmatic basis versus a lease-sale specific analysis. The purpose of this coordination is to ensure that NMFS and FWS have the opportunity to review postlease exploration, development and production activities (prior to BOEM approval) to ensure all approved plans and permits contain any necessary measures to avoid jeopardizing the existence of any ESA-listed species or precluding the implementation of any reasonable and prudent alternative measures. While formal consultation and the development of a new Biological Opinion is ongoing, BOEM and BSEE have implemented an interim coordination program with NMFS and FWS for the review of postlease activities requiring permits or plan approvals.

Nonendangered Species

One baleen cetacean (Bryde's whale) and 19 toothed cetaceans (including beaked whales and dolphins) occur in the Gulf of Mexico. None of these species are protected under the ESA; however, all marine mammals are protected under the Marine Mammal Protection Act (1972).

Cetaceans—Mysticetes

The only commonly occurring baleen whale in the northern Gulf of Mexico is the Bryde's whale (*Balaenoptera edeni*). The other baleen whales that have been sighted in the GOM are either considered rare or extralimital by Waring et al. (2011). The Bryde's whale (*Balaenoptera edeni*) is found in tropical and subtropical waters throughout the world. They feed on small pelagic fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993). Bryde's whales in the northern GOM, with few exceptions, have been sighted along a narrow corridor near the 100-m (328-ft) isobath (Davis and Fargion, 1996; Davis et al., 2000). Most sightings have been made in the De Soto Canyon region and off western Florida, although there have been some in the west-central portion of the northeastern GOM. The best estimate of abundance for Bryde's whales in the northern GOM is 15 individuals (Waring et al., 2011).

Cetaceans—Odontocetes

Family Kogiidae

The pygmy sperm whale (*Kogia breviceps*) has a worldwide distribution in temperate to tropical waters (Caldwell and Caldwell, 1989). They feed mainly on squid but they will also eat crabs, shrimp, and smaller fishes (Würsig et al., 2000). In the GOM, they occur primarily along the continental shelf edge and in deeper waters off the continental shelf (Mullin et al., 1991).

The dwarf sperm whale (*Kogia sima*) can also be found worldwide in temperate to tropical waters (Caldwell and Caldwell, 1989). It is believed that they feed on squid, fishes, and crustaceans (Würsig et al., 2000). In the GOM, they are found primarily along the continental shelf edge and over deeper waters off the continental shelf (Mullin et al., 1991).

At sea, it is difficult to differentiate dwarf from pygmy sperm whales (*Kogia breviceps*), and sightings are often grouped together as "*Kogia* spp." The best estimate of abundance for dwarf and pygmy sperm whales combined in the northern GOM is 453 individuals (Waring et al., 2011).

Family Ziphiidae (Beaked Whales)

Beaked whales in the GOM are identified either as Cuvier's beaked whales or are grouped into an undifferentiated complex (*Mesoplodon* spp. and *Ziphius* spp.) because of the difficulty of at-sea identification. In the northern GOM, they are broadly distributed in waters greater than 1,000 m (3,281 ft) over lower slope and abyssal landscapes (Davis et al., 1998 and 2000). The abundance estimate for the Cuvier's beaked whale is 65 animals, and for the undifferentiated beaked whale complex in the northern GOM, it is 57 individuals (Waring et al., 2011). Beaked whales were seen in the GOM in all seasons during GulfCet aerial surveys (Mullin and Hoggard, 2000).

Three species of *Mesoplodon* are known to occur in the GOM based on sighting and stranding data (Wursig et al. 2000). The Gervais' beaked whale (*Mesoplodon europaeus*) appears to be widely but sparsely distributed worldwide in temperate to tropical waters (Leatherwood and Reeves 1983). Little is known about their life history, but it is believed that they feed on squid (Würsig et al., 2000). Stranding records suggest that this is probably the most common mesoplodont in the northern GOM (Jefferson and Schiro, 1997). The GOM population is provisionally being considered a separate stock for management purposes, although there are no data to differentiate this from Atlantic Ocean stock(s) (Waring et al. 2011). The Blainville's beaked whale (*Mesoplodon densirostris*) is distributed throughout temperate and tropical waters worldwide, but it is not considered common (Würsig et al., 2000). Little life history is known about this secretive whale, but it is known to feed on squid and fish. This stock is also provisionally considered a separate stock from the Atlantic Ocean stocks. The Sowerby's beaked whale (*Mesoplodon bidens*) occurs in cold temperate to subarctic waters of the North Atlantic and is considered extralimital in the GOM (Jefferson and Schiro, 1997).

Cuvier's beaked whale (*Ziphius cavirorostris*) is widely (but sparsely) distributed throughout temperate and tropical waters worldwide (Würsig et al., 2000). They are sighted in the GOM in all seasons in water depths typically greater than 500 m (1,640 ft) (Maze-Foley and Mullin 2006). Their diet consists of squid, fishes, crabs, and starfish. Sightings data indicate that Cuvier's beaked whale is probably the most common beaked whale in the GOM (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). The GOM stock is provisionally being considered a separate stock for management purposes, although there are no data to differentiate this from the Atlantic Ocean stock(s).

Family Delphinidae (Dolphins)

The Atlantic spotted dolphin (*Stenella frontalis*) is endemic to the Atlantic Ocean in tropical to temperate waters (Perrin et al., 1994a). They are known to feed on a wide variety of fishes, cephalopods, and benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Perrin et al., 1994a). In the GOM they are commonly found in continental shelf waters less than 200 m (656 ft) in depth, primarily from 10 m (33 ft) on the shelf to up to 500 m (1,640 ft) on the slope. The abundance estimate for continental shelf and oceanic waters of the GOM is 37,611 (Waring et al. 2011); however, because the data from the continental shelf surveys are greater than 8 years old, a current best population estimate for this species in the GOM is unknown.

The bottlenose dolphin (*Tursiops truncatus*) is a common inhabitant of the continental shelf and upper slope waters of the northern GOM. Bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, and shrimp (Davis and Fargion, 1996; Jefferson and Schiro, 1997; Wells and Scott, 1999). There appears to be two ecotypes of bottlenose dolphins, a coastal form and an offshore form (Hersh and Duffield, 1990; Mead and Potter, 1990). The coastal or inshore stock(s) is genetically isolated from the offshore stock (Curry and Smith, 1997). Inshore stocks are further delineated into 32 separate provisionally delineated northern Gulf of Mexico bay, sound, and estuarine stocks (Waring et al. 2011). In the northern GOM, bottlenose dolphins appear to have an almost bimodal distribution: shallow water (16-67 m; 52-210 ft) and a shelf break (about 250 m; 820 ft) region. These regions may represent the individual depth preferences of the coastal and offshore forms (Baumgartner, 1995). The best estimate of abundance for bottlenose dolphins in the northern GOM is 42,841 individuals. This estimate includes oceanic, continental shelf, and coastal stocks; however, many of these abundance estimates are greater than 8 years old (Waring et al., 2011).

The Clymene dolphin (*Stenella clymene*) is endemic to tropical and subtropical waters of the Atlantic Ocean (Perrin and Mead, 1994). This species is thought to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994a). Data suggest that Clymene dolphins are widespread within deeper GOM waters (i.e., shelf edge and slope) (Davis et al., 2000; Würsig et al., 2000). The abundance estimate for the Clymene dolphin in the northern GOM is 6,575 individuals (Waring et al., 2011).

The Fraser's dolphin (*Lagenodelphis hosei*) has a worldwide distribution in tropical waters (Perrin et al., 1994b). Fraser's dolphins feed on fishes, cephalopods, and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Jefferson and Schiro, 1997). In the GOM, they occur in deeper waters off the continental shelf. The best abundance estimate for this species in the northern GOM is unknown (Waring et al., 2011).

The pantropical spotted dolphin (*Stenella attenuata*) is distributed in tropical and subtropical waters worldwide (Perrin and Hohn, 1994). It feeds on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). It is the most common cetacean in the oceanic northern GOM (Mullin et al., 1994b) and is found in the deeper waters off the continental shelf (Mullin et al., 1994b; Davis et al., 1998 and 2000). The abundance estimate for the pantropical spotted dolphin in the northern GOM is 34,067 individuals (Waring et al., 2011).

The Risso's dolphin *Grampus griseus*) is distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves, 1983). They feed primarily on squid and secondarily on fishes and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily along the continental shelf and continental slope (Mullin and Fulling, 2004). The abundance estimate for the Risso's dolphin in the northern GOM is 1,589 individuals (Waring et al., 2011).

The rough-toothed dolphin (*Steno bredanensis*) occurs in tropical to warm temperate waters worldwide (Miyazaki and Perrin, 1994). This species feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily over the deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimate for the rough-toothed dolphin in the northern GOM (both oceanic waters and the outer continental shelf) is 2,653 individuals; however, because data from continental shelf populations are greater than 8 years old ,the current best population estimate is unknown (Waring et al., 2011).

The spinner dolphin (*Stenella longirostris*) occurs worldwide in tropical and warm temperate waters (Perrin and Gilpatrick, 1994; Jefferson and Schiro, 1997), primarily in offshore, deepwater environments. They feed on mesopelagic fishes and squid (Würsig et al., 2000). In the northern GOM, they occur in deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimate for the spinner dolphin in the northern GOM is 1,989 individuals (Waring et al., 2010).

The striped dolphin (*Stenella coeruleoalba*) occurs in tropical to temperate oceanic waters (Perrin et al., 1994c). They feed primarily on small, mid-water squid and fishes, especially lanternfish (myctophid). In the GOM, they occur in the deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimate for the striped dolphin in the northern GOM is 3,325 individuals (Waring et al., 2011).

The false killer whale (*Pseudorca crassidens*) occurs worldwide in tropical and temperate oceanic waters (Odell and McClune, 1999). False killer whales primarily eat fish and cephalopods, but they have been known to attack other toothed whales (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, most sightings occur in deeper waters off the continental shelf (Davis and Fargion, 1996). The abundance estimate for the false killer whale in the northern GOM is 777 individuals (Waring et al., 2011).

The killer whale (*Orcinus orca*) has a worldwide distribution from tropical to polar waters (Dahlheim and Heyning, 1999). They feed on marine mammals, marine birds, sea turtles, cartilaginous and bony fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily in the deeper waters off the continental shelf (Davis and Fargion, 1996). The abundance estimate for the killer whale in the northern GOM is 49 individuals (Waring et al., 2011).

The melon-headed whale (*Peponocephala electra*) has a worldwide distribution in subtropical to tropical waters (Jefferson et al., 1992), feeding on cephalopods and fishes (Mullin et al., 1994a; Jefferson and Schiro, 1997). In the GOM, they occur in the deeper waters off the continental shelf (Mullin et al., 1994b). The abundance estimated for the melon-headed whale in the northern GOM is 2,283 individuals (Waring et al., 2011).

The pygmy killer whale (*Feresa attenuata*) occurs worldwide in tropical and subtropical waters (Ross and Leatherwood, 1994). Its diet includes cephalopods and fishes, though reports of attacks on other dolphins have been reported (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily in deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimate for the pygmy killer whale in the northern GOM is 323 individuals (Waring et al., 2011).

The short-finned pilot whale (*Globicephala macrorhynchus*) is distributed worldwide in tropical to temperate waters (Leatherwood and Reeves, 1983). They feed predominately on squid, with fishes being consumed occasionally (Würsig et al., 2000). In the GOM, they are most frequently sighted along the continental shelf and continental slope. The abundance estimate for the northern GOM is 716 individuals (Waring et al., 2011).

Factors Influencing Cetacean Distribution and Abundance

The distribution and abundance of cetaceans within the northern Gulf of Mexico is strongly influenced by various mesoscale oceanographic circulation patterns. These patterns are primarily driven by river discharge (primarily the Mississippi River), wind stress, and the Loop Current and its derived circulation phenomena. Circulation on the continental shelf is largely wind-driven, with localized effects from freshwater (i.e., river) discharge. Beyond the shelf, mesoscale circulation is largely driven by the Loop Current in the eastern Gulf of Mexico. Approximately once or twice a year, the Loop Current sheds anticyclonic eddies (also called warm-core rings). Anticyclones are long-lived, dynamic features that generally migrate westward and transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf of Mexico. These anticyclones, in turn, spawn cyclonic eddies (also called cold-core rings) during interaction with one another and upon contact with topographic features of the continental slope and shelf edge. These cyclones contain and maintain high concentrations of nutrients and stimulate localized production (Davis et al., 2000). In the north-central Gulf of Mexico, the relatively narrow continental shelf south of the Mississippi River Delta may be an additional factor affecting cetacean distribution (Davis et al., 2000). Outflow from the mouth of the Mississippi River transports large volumes of low-salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow also may be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. Marine predators such as the bottlenose dolphin focus their foraging efforts on these abundant prey locations to improve overall efficiency and reduce energy costs (Bailey and Thompson, 2010).

Unusual Mortality Event for Cetaceans in the Gulf of Mexico

On December 13, 2010, NMFS declared an unusual mortality event (UME) for cetaceans (whales and dolphins) in the Gulf of Mexico. An UME is defined under the Marine Mammal Protect Act as a "stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response." Evidence of the UME was first noted by NMFS as early as February 2010, before the DWH event. As indicated in **Table 4-5,** a total of 723 cetaceans (4% stranded alive and 96% stranded dead) have stranded since the start of the UME, with a vast majority of these strandings involving premature, stillborn, or neonatal bottlenose dolphins between Franklin County, Florida, and the Louisiana/Texas border (just west of the CPA). The 723 cetaceans include 6 dolphins killed during a fish-related scientific study and 1 dolphin killed incidental to a dredging operation.

More detail on the UME can be found on NMFS's website (USDOC, NMFS, 2012a). In addition to investigating all other potential causes, scientists are investigating what role *Brucella* may have played in the UME, and this continues today.

It is unclear at this time whether the increase in strandings is related partially, wholly, or not at all to the DWH event. The NMFS has also documented an additional 11 UME's that have been previously declared in the GOM for cetaceans since 1991. However, the current data in **Table 4-5** also show a marked increase in strandings during the DWH-event response and afterwards. According to their website, NMFS considers the investigation into the cause of the UME and the potential role of the DWH event to be "ongoing and no definitive cause has yet been identified for the increase in cetacean strandings in the northern Gulf in 2010 and 2011." It is therefore unclear whether increases in stranded cetaceans during and after the DWH-event response period are or are not related to impacts from the DWH event, and it will likely remain unclear until NMFS completes its UME and NRDA evaluation processes.

All marine mammals collected either alive or dead were found east of the Louisiana/Texas border through Franklin County, Florida. The highest concentration of strandings has occurred off eastern Louisiana, Mississippi and Alabama with a significantly lesser number off western Louisiana and western Florida (USDOC, NMFS, 2012a).

Deepwater Horizon Event

The DWH event in Mississippi Canyon Block 252 and the resulting oil spill and related spill-response activities (including use of dispersants) have impacted marine mammals that have come into contact with oil and remediation efforts. According to the Dolphins and Whales of the Gulf of Mexico Oil Spill website, within the designated DWH spill area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 Kogia spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NMFS, 2011a). All marine mammals collected either alive or dead were found east of the Louisiana/Texas border through Apalachicola, Florida. The highest concentration of strandings has occurred off eastern Louisiana, Mississippi, and Alabama, with a significantly lesser number off western Louisiana and western Florida (USDOC, NMFS, 2011a). Due to known low-detection rates of carcasses, it is possible that the number of deaths of marine mammals is underestimated (Williams et al., 2011). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses collected were related to the DWH oil spill. These stranding numbers are significantly greater than reported in past years; though it should be further noted that stranding coverage (i.e., effort in collecting strategies) has increased considerably due to the DWH event.

Marine Mammal Resources in the Central Planning Area

The final determinations on damages to marine mammal resources from the DWH event will ultimately be made through the NRDA process. The DWH event will ultimately allow a better understanding of any realized effects from such a low-probability catastrophic spill. However, the best available information on impacts to marine mammals does not yet provide a complete understanding of the effects of the oil spill and active response/cleanup activities from the DWH event on marine mammals as a whole in the GOM and whether these impacts reach a population level. There is also an incomplete understanding of the potential for population-level impacts from the ongoing UME.

Here, BOEM concludes that the unavailable information from these events may be relevant to reasonably foreseeable significant adverse impacts to marine mammals. In some specific cases, such as with bottlenose dolphins as noted below, the unavailable information may also be relevant to a reasoned choice among the alternatives based on the discussion below. The cost of obtaining data on the effects from the UME and/or DWH event are exorbitant; duplicative of efforts already being undertaken as part of the UME and NRDA and would likewise take years to acquire and analyze through the existing NRDA and UME processes. Further, impacts from the DWH event may be difficult or impossible to discern from other factors. For example, even 20 years after the *Exxon Valdez* spill, long-term impacts to marine mammal populations are still being investigated (Matkin et al., 2008). Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches..

The BOEM does, however, provide the following analyses for select marine mammal species and as they relate to the CPA, relevant to the DWH event and UME discussion:

- **Sperm whales** are found in oceanic waters throughout the GOM and appear to be a resident species. During and following the DWH event and response, two dead sperm whales have been documented within the DWH affected area (USDOC, NMFS, 2011a). It is yet unknown whether the DWH event was the cause of death for these two individuals. Waring et al. (2011) reported the estimated population size of the northern GOM sperm whale population to be 1,665 individuals. Further, the Potential Biological Removal for this population is 2.8 animals, based on a minimum population estimate of 1,409. The Potential Biological Removal is defined as "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population" (Waring et al., 2011). If a protective assumption is made that the two sperm whales detected above were removed from the population as a result of the spilled oil and not natural causes (and coincidentally found floating in oiled areas), then the Potential Biological Removal was not reached. Given other sperm whales may have been killed but gone undetected (again this is a protective assumption due to low detection rates as described above), there is the potential that the Potential Biological Removal was reached and the population would no longer be operating at its optimum sustainable level.

  It is important to note that "optimum sustainable level" does not mean jeopardy to the population (i.e., a change leading to extinction). Rather, it is defined under the MMPA to mean "a population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem to the population level that results in maximum net productivity. Maximum net productivity is the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality" (50 CFR 216.3). In contrast, the term "jeopardy" under the ESA means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). So, exceeding the Potential Biological Removal does not imply jeopardizing the continued existence of the population but rather that it may no longer be operating as its optimum sustainable level.

  The BOEM concludes that the unavailable information resulting from the DWH event and its impact to the sperm whale population baseline could be relevant to reasonably foreseeable significant adverse effects. Although activities will be ongoing under active leases (4,377 active leases in CPA as of May 2012) whether or not a CPA proposed action takes place, BOEM at this point cannot determine if potential data and information incoming from the DWH event would be essential to a reasoned choice among the alternatives. As noted above, these data are being developed through the NRDA process and at the direction of NMFS (which has jurisdiction over marine mammal strandings). It will be years before the studies currently under way produce available data. Little data, beyond raw numbers of strandings, have been made public through the NRDA process. For example, new data are still being investigated and developed 20 years after the *Exxon Valdez* event. In any event, this information will not be available within the timeframe contemplated by this NEPA analysis. In its place, the scientifically credible information that is available has been incorporated using accepted scientific methodologies. In addition, the ESA consultation, which includes sperm whales, has been reinitiated and is ongoing; an interim coordination program, which may inform additional mitigations, is being developed with NMFS and FWS.

- **Bryde's whale** is the only known baleen whale species to occur regularly in the Gulf of Mexico. The NMFS treats Bryde's whales found in the northern GOM as a separate stock and estimates a minimum population size at 15 animals. Most sightings have occurred (based on limited survey effort) within De Soto Canyon, which are deeper waters off the coasts of Alabama and the western panhandle of Florida (Waring et al., 2011). It is unknown whether any individuals of this stock were affected by the DWH event, although no reports of effects to Bryde's whales have been made at this time. There is then the potential that this unavailable information could be relevant to reasonably foreseeable significant adverse effects. Activities will be ongoing under active leases (4,377 active leases in CPA as of May 2012) whether or not a CPA proposed action takes place. However, baseline information about this population even prior to the DWH event was minimal, and BOEM at this point cannot determine if potential data and information incoming from the DWH event would be essential to a reasoned choice among the alternatives. Due to difficulties inherent in researching this species in the Gulf (e.g., small population size), it is unlikely that research could be initiated, completed, and analyzed within the timeframe contemplated by this NEPA analysis. The NRDA process may provide additional information about this species and potential impacts from the DWH event; however, these data are not currently available and it may be years before such data are released or known. What scientifically credible information is available has been incorporated and applied using accepted scientific methodologies.

- The major concentrations of stranded **bottlenose dolphins** from the ongoing UME occur within the eastern Louisiana, Mississippi, and Alabama coasts (USDOC, NMFS, 2012a). A CPA proposed action also covers these same areas.

  For bottlenose dolphins, BOEM concludes that the unavailable information resulting from the DWH and UME events could be relevant to reasonable foreseeable significant adverse effects. The OCS activities will be ongoing under active leases (4,377 active leases in CPA as of May 2012) whether or not the proposed action or any other alternative are selected. However, BOEM believes that the unavailable information may be essential to a reasoned choice among alternatives, particularly regarding the dolphin stocks affected by the UME and/or DWH events. The NMFS is the lead agency investigating marine mammal strandings, including both the current UME and the DWH event. To date, NMFS has released only raw data on strandings. We are therefore unable to determine, at this point and time, what effect (if any) the DWH event had on bottlenose dolphins also affected by the UME. Due to legal constraints with marine mammal strandings (left solely within NMFS's jurisdiction), BOEM does not have the ability to obtain its own data on stranded animals. The NMFS process will attempt to determine the cause of the UME, but this may take years to complete. Impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

- **Manatees** generally occur in the GOM along the Gulf Coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida during warmer months (June to September) and southward during the winter. They are less common farther west; however, individuals have been increasingly spotted as far as Texas during the summer months (Fertl et al., 2005). Further, there have not been any reported cases of manatees within areas affected by the DWH event. The BOEM concludes that available information is sufficient to conclude that there was

> likely little to no effect to manatees from the DWH event and that the potential for impacts from a CPA proposed action or its alternatives also remains insignificant given the distance and the low number of manatees that may occur within a CPA proposed action area.

The final determinations on impacts to marine mammal resources from the DWH event will ultimately be made through the NRDA process. The DWH event will ultimately allow a better understanding of any realized effects from such a low-probability catastrophic spill. However, the best available information on impacts to marine mammals does not yet provide a complete understanding of the effects of the oil spill and active response/cleanup activities from the DWH event on marine mammals as a whole in the GOM and whether these impacts reach a population level. There is also an incomplete understanding of the potential for population level impacts from the ongoing UME. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to marine mammals. Relevant data on the status of marine mammal populations after the UME and DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. For example, even 20 years after the *Exxon Valdez* spill, long-term impacts to marine mammal populations are still being investigated (Matkin et al., 2008). Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

4.2.1.12.2. Impacts of Routine Events

The potential effects on marine mammal species may occur from routine activities associated with a CPA proposed action. The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by aircraft, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and marine debris from service vessels and OCS structures.

Discharges

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced sand and well treatment, workover, and completion fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater. Discharges are regulated by the U.S. Environmental Protection Agency's NPDES permits.

Most operational discharges are diluted and dispersed when released in offshore areas, and they are not expected to directly affect any marine mammal species (Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (Neff et al., 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web.

Heavy metal accumulations in marine mammal tissues are of concern worldwide (Bossart, 2006). Trace metals, including mercury, in drilling discharges have been a particular concern. However, Neff et al. (1989) concluded that metals associated with drilling fluid were virtually nonbioavailable to marine organisms. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from live GOM and Atlantic bottlenose dolphins showed high levels of polyfluoroalkyl compounds (Houde et al., 2005). Recent work by Kucklick et al. (2011) in the Gulf of Mexico identified a number of persistent organic pollutants in bottlenose dolphins, and Fair et al. (2010) documented unusually high levels of organic chemicals in bottlenose dolphins in Atlantic populations. Adequate baseline data are not available to determine the significant sources of contaminants that accumulate in Gulf cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the GOM from a variety of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. Coastal cetacean species tend to have higher levels of metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights (either helicopter or fixed-wing) in close proximity to marine mammals may elicit a startle response due to either the increasing noise as the aircraft approaches or due to the physical presence of the aircraft in the air. Marine mammals often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as species, the activity the animals are engaged in, and water depth (Richardson et al., 1995). Marine mammals engaged in feeding or social behavior are often insensitive to overflights, while those in confined waters or those with calves may be more responsive. The effects appear to be transient, and there is no indication that long-term displacement of marine mammals occurs. However, the absence of conspicuous response does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Aircraft noise is generally short in duration and transient in nature, although it may ensonify large areas. At incident angles of greater than 13 degrees from the vertical, much of the noise from a passing aircraft is reflected and does not penetrate the water (Urick, 1972). Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters, while flying offshore, generally maintain altitudes above 700 ft (213 m) during transit to and from the working area and an altitude of about 500 ft (152 m) between platforms.

Vessel Noise and Operation

The dominant source of human sound in the sea is ship noise (Tyack, 2008). Both the noise from the vessel's operations and the potential for ship strikes could potentially impact marine mammals. The primary sources of vessel noise are propeller cavitations, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). The intensity of noise from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladed vessels. For a given vessel, relative noise also tends to increase with increased speed. The ambient noise environment in the GOM is filled with ship "noise" associated with oil and gas activities, shipping, and recreational vessels raising concerns that elevated levels of noise may interfere with the behavior and physiology of marine mammals (Tyack, 2008). Impacts from vessel noise could disturb animals in the immediate vicinity of the vessel; however, the noise would be transitory in nature.

Collisions of vessels with marine mammals are not uncommon (Laist et al., 2001). Vanderlaan and Taggert (2007) examined the literature for large whale species and reported that the probability for vessel strikes is largely a function of vessel speed. Although the sperm whale is the most likely large whale to be struck by a vessel in the GOM, there has only been one possible mortality due to vessel strike documented (Waring et al., 2011). Data compiled by Laist et al. (2001) indicate that relatively large (>80 m; 262 ft) and fast-moving vessels (>14 kn; 16 mph) are most commonly involved in collisions with marine mammals. They also conclude that the majority of collisions appear to occur over or near the continental shelf and that the whales usually are not seen beforehand or are seen too late to be avoided. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001; Vanderlaan and Taggert, 2007).

Increased traffic from service and support vessels would increase the probability of collisions between vessels and marine mammals. These collisions can cause major injuries and/or fatalities (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 2011). Slow-moving cetaceans or those that spend extended periods of time at the surface might be expected to be the most vulnerable (Vanderlaan and Taggert, 2007). Smaller delphinids often approach vessels that are in transit to bow-ride; however, vessel strikes are less common for these faster moving mammals or are underreported (Wells and Scott, 1997). Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared with control periods (no boats present within 100 m [328 ft]) in a study conducted in Sarasota Bay, Florida. They also found that dolphins' decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Evidence suggests that some whale species have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy vessel traffic indicates a considerable degree of tolerance to vessel noise and disturbance. Vessel noise could interfere with marine mammal communication either by masking important sounds from conspecifics, masking sounds from predators, or by forcing animals to alter their vocalizations (Tyack, 2008). There is the possibility of short-term disruption of movement patterns and/or behavior caused by vessel noise and disturbance; however, these are not expected to impact survival and growth of any marine mammal populations in the GOM. The BOEM and BSEE issued NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which provides guidance for vessel strike avoidance and reporting.

Florida manatees are found in shallow coastal waters along the entire northern GOM from Florida to Texas (Fertl et al., 2005). Vessel strikes are the most common cause of human-induced mortality for manatees (Florida Fish and Wildlife Commission, Fish and Wildlife Research Institute, 2010a). Service and support vessels traveling through coastal areas to and from oil and gas structures have the potential to impact manatees by vessel collisions. In 1995, an oil crew workboat struck and killed a manatee in a canal near coastal Louisiana (Fertl et al., 2005). Inadequate hearing sensitivity at low frequencies (Gerstein et al., 1999), slow movement, and use of shallow and surface waters are contributing factors to their vulnerability to vessel strike impacts.

Drilling and Production Noise

Drilling and production activities produce underwater sounds that may be detected by marine mammals. Noise produced by these types of activities are generally low frequency sounds and have the potential to mask cetaceans' reception of sounds produced for echolocation and communication. Most species of marine mammals in the GOM (except the Bryde's whale) use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Baleen whales use low-frequency sounds that overlap broadly with the dominant frequencies of many industrial sounds, and there are indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995).

Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Noise from these operations may impact marine mammals similarly to other anthropogenic sounds in the ocean. Noise can mask important sounds from conspecifics, mask sounds from predators, or force animals to alter their vocalizations. Sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. The response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include the disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Some demographic groups may be more vulnerable to noise impacts, including females in late pregnancy or lactating. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but marine mammals may be affected by noise in difficult-to-observe ways. For example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but it is little studied in marine mammals. Tyack (2008) suggests that a more significant risk to marine mammals from sound are these less visible effects of chronic exposure. Drilling and production noise would contribute to increases in the ambient noise environment of the GOM, but they are not expected in amplitudes sufficient to cause either hearing or behavioral effects.

Structure Removals

The use of explosives is the preferred method for the severance of structures from their foundations in the GOM. The shock wave and blast noise from explosions are of most concern to marine animals. Depending on the intensity of the shock wave and size and depth of the animal, an animal can be injured or killed. Farther from the blast, an animal may suffer nonlethal physical effects. Outside of these zones of death and physical injuries, marine animals may experience hearing-related effects with or without behavioral responses. A limited amount of information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998).

Injuries resulting from a shock wave take place at boundaries between tissues of different density. Different velocities are imparted to tissues of different densities, and this can lead to their physical disruption. Blast effects are greatest at the gas-liquid interface (Landsberg, 2000). Because the ears are the most sensitive to pressure, they are the organs most sensitive to injury (Ketten, 2000). If an animal is able to hear a noise, at some level it can damage its hearing by causing decreased sensitivity (Ketten, 1995). Sound-related trauma can be lethal or sublethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source and are not, technically, pure acoustic trauma (Ketten, 1995). Sublethal impacts include hearing loss, which is caused by exposures to perceptible sounds.

Toothed whales cannot hear well in the frequencies emitted by explosive detonations (Richardson et al., 1995). At greater distances from the blast, marine mammals may not experience any physical injuries but may be able to "feel" the blast, be startled, respond to the sound with a change in behavior, or may also tolerate the sound. Sublethal effects would include a startle response. Marine mammals may be affected by the changes in water quality resulting from suspended sediments, but information is limited on these impacts.

The Galveston Laboratory of NMFS's Southeast Fisheries Science Center has been gathering information on the presence of marine mammals (and sea turtles) at nearly all explosive structure-removal operations (Gitschlag et al., 1997). To date, there is no evidence linking marine mammal injuries or deaths in the GOM to the explosive removal of structures.

In 2005, this Agency petitioned NMFS for incidental-take regulations under the MMPA to address the potential injury and/or mortality of marine mammals that could result from the use of explosives during decommissioning activities. Similarly, BOEMRE initiated ESA Section 7 Consultation efforts with NMFS to cover potential explosive-severance impacts to threatened and endangered species such as sperm whales (and sea turtles). The ESA Consultation was completed in August 2006 and the final MMPA rule was published in June 2008. The mitigation, monitoring, and reporting requirements from the current ESA Biological Opinion/Incidental Take Statement and MMPA regulations mirror one another and allow explosive charges up to 500 lb (227 kg), internal and external placement, and both above-mudline and below-mudline detonations.

The BOEMRE issued "Decommissioning Guidance for Wells and Platforms" (NTL 2010-G05) to offshore operators. These guidelines specify and reference mitigations requirements in the current ESA and MMPA guidance, and they require that trained observers watch for protected species (sea turtles and marine mammals) in the vicinity of the structures to be removed.

Seismic Surveys

The effects of sounds from airguns could include one or more of the following: masking of natural sounds; behavioral disturbance; tolerance; and temporary or permanent hearing impairment, or nonauditory physical or physiological effects (Richardson et al., 1995; Nowacek et al., 2007; Southall et al., 2007). Permanent hearing impairment would constitute injury; however, temporary threshold shift is not considered an injury (Southall et al., 2007).

Seismic surveys use a high-energy noise source (airgun and/or airgun array). Historically, seismic survey airguns have been considered low-frequency energy (<200 Hz) sources. Acoustic signals in this frequency range would be inaudible to dolphin species, given their high frequency-biased hearing and their relatively poor sensitivity at low frequency. However, recent measurements of airgun sources at sea (Goold and Fish, 1998; Sodal, 1999) have demonstrated that, although airgun arrays are a source of primarily low-frequency sound energy, a higher frequency energy component is also transmitted. Airgun sound energy encompasses the entire audio frequency range from 20 Hz to 20 kHz (Goold and Fish, 1998) and extends well into the ultrasonic range to 50 kHz (Sodal, 1999).

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys, but they exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km (4-5 mi) of an airgun array. Humpback whales off Western Australia were found to change course at 3-6 km (2-4 mi) from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (2-2.5 mi) (McCauley et al., 1998a and 1988b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km (4-7 mi) from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). Studies have focused on mysticetes due to the existing overlap between the expected frequencies of good hearing sensitivity (low threshold) in mysticetes and maximal airgun output. Mysticetes, however, do not occur commonly in the GOM, with only Bryde's whale occurrences having been documented with any regularity, although even their occurrence is considered uncommon in the GOM (Waring et al., 2011). Although there have been no studies of the reaction of Bryde's whale to seismic activities, it is generally considered that the auditory abilities of all mysticete species are broadly similar, based upon vocalization frequencies and ear anatomy (Ketten, 1998). Limited data on Bryde's whale reactions to other anthropogenic disturbances suggest little response to slowly approaching boats (Watkins, 1981) and that this species, like others, also appears to be easier to approach when feeding (Gallardo et al., 1983).

Few studies on the impact of seismic surveys on other odontocetes' behavior have been conducted (Richardson et al., 1995; Gordon et al., 2004; Southall et al., 2007). Goold (1996) reported that the behavior of common dolphins, especially the vocalization rate, within 1 km (0.6 mi) of a seismic source at a received level of about 133 dB re 1 µPa was affected by the seismic source signal. Wakefield (2001) demonstrated that certain common dolphin vocalization (whistle) parameters changed during airgun signal transmission, specifically (1) there is an increase in the start, end, minimum and mean frequencies of the whistles, and (2) the frequency contours of the whistles become flatter. The significance of these changes is not clear but perhaps signifies adaptation to seismic noise. Miller et al. (2005) found that beluga whales exhibited avoidance behavior during seismic airgun operations by leaving the waters within a distance of 10-20 km (6-12 mi) from the airgun source; during airgun signal transmissions, a higher number of beluga whales were suddenly observed 20-30 km (12-19 mi) from the airgun source. Belugas exposed to received levels of 100-120 dB re 1 µPa (over pulse duration) did not exhibit any changes in behavior, while beluga whales exposed to received levels of 120-150 dB re 1 µPa exhibited temporary avoidance behavior (Miller et al., 2005; Southall et al., 2007). Stone (1996, 1997a, 1997b, and 1998) reported that common dolphins, white beaked dolphins, and white-sided dolphins were sighted in the vicinity of seismic surveys less often when the guns were firing than when they were not firing, and these observations were statistically significant for common dolphins. Weir (2008) found few obvious visible responses of sperm (and humpback) whales to seismic airgun sounds off Angola, only overt responses were examined, and subtle or longer range responses may not have been detected.

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given the transitory nature of seismic exploration, the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals, and the avoidance responses that occur in at least some baleen whales when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Since the previous 2007-2012 Multisale EIS (USDOI, MMS, 2007c) and the Biological Opinion from NMFS (USDOC, NMFS, 2007b), this Agency completed the Sperm Whale Seismic Study, and a synthesis report was published in 2008 (Jochens et al., 2008). Two principle conclusions from this multiyear research effort regarding the impacts of seismic activity on sperm whales were that there appeared to be no horizontal avoidance to controlled exposure of seismic airgun sounds by sperm whales in the main Sperm Whale Seismic Study area and that data suggest it is more likely than not that some decrease in foraging effort may occur during exposure to full-array airgun firing as compared with the post-exposure condition, at least for some individuals (Miller et al., 2009). Recommendations from the study included continued controlled exposure experiments to investigate the potential impacts of seismic surveys on whale foraging.

The NMFS published a notice of receipt of application for an incidental take authorization from this Agency in 2003, this application requested comments and information on taking marine mammals incidental to conducting oil and gas exploration activities in the GOM (68 FR 9991). In 2004, NMFS published a notice of intent to prepare an EIS, notice of public meetings, and request for scoping comments, for the requested authorizations (69 FR 67535). In April 2011, NMFS received a revised complete application from BOEM requesting an authorization for the take of marine mammals incidental to seismic surveys on the OCS in the GOM (76 FR 34657). The NMFS has not finalized the EIS at this time. This Agency completed a Programmatic EA on G&G permit activities in the GOM (USDOI, MMS, 2004). This Programmatic EA includes a detailed description of the seismic surveying technologies, energy output, and operations, and it is hereby incorporated by reference.

The BOEM and BSEE have mitigations in place (NTL 2012-JOINT-G02) that require G&G operators conducting seismic operations in all Federal waters >200 m (656 ft) deep in the CPA and WPA and in all Federal waters of the EPA (regardless of water depth) to (1) employ ramp-up, (2) utilize trained protected species observers, and (3) complete BOEM reporting requirements. Ramp-up is to be initiated only during periods of sufficient visibility when observers are able to scan and clear an area (i.e., impact radius, or exclusion zone) at least 500 m (1,640 ft) around seismic operations. Specifically, the NTL requires that visual protected species observers clear the exclusion zone at and below the sea surface within a radius of 500 m (1,640 ft) surrounding the center of an airgun array and the area within the immediate vicinity of the survey vessel. Observers must observe no marine mammals or sea turtles within (or approaching) the 500-m (1,640-ft) exclusion zone for a period of 30 minutes, after which ramp-up operations may begin. Once ramp-up has been completed and the seismic array is operating at full power, visual observations are to continue until seismic operations cease or sighting conditions do not allow observation of the sea surface (e.g., fog, rain, and darkness). If a whale (but not dolphins) or sea turtle is sighted either within the 500-m (1,640-ft) exclusion zone or moving towards the exclusion zone, the array must be shut down until the area can be cleared. The seismic array may be powered down to a minimum level of 160 dB re 1μPa (rms) without reinitiating ramp-up. Procedures for ramp-up, protected species observers' training, visual monitoring, and reporting are described in detail in NTL 2012-JOINT-G02 and in the section below.

Marine Debris

Marine debris has the potential to impact marine mammals primarily through ingestion or entanglement. The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes from a variety of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997); however, ingestion of net materials can also be fatal (Jacobsen et al., 2010). Recent information (Sheavely, 2007) reports that as much as 49 percent of marine debris is considered land-based. There are many types of materials used in offshore energy production and the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995).

The BSEE prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.300). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established on January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. The accidental release of debris from OCS activities is known to occur offshore, and ingestion of, or entanglement in, discarded material could injure or kill cetaceans. The BSEE provides information on marine debris and awareness and requires training of all OCS personnel through the "Marine Trash and Debris Awareness and Elimination" NTL (NTL 2012-BSEE-G01).

Proposed Action Analysis

The NMFS recognized in their 2007 Biological Opinion for oil and gas activities in the CPA (and WPA) that the routine activities most likely to impact marine mammals (e.g., the sperm whale) were vessel strikes, seismic noise, and structure removals. The BOEM has completed separate programmatic evaluations of these activities and has consulted with NMFS on both explosive removals and seismic noise. Marine mammal injury is not expected from explosive structure-removal operations. Existing guidelines and reference mitigation requirements stipulate that trained observers watch for protected species in the vicinity of the structures to be removed (NTL 2010-G05) to minimize adverse effects to marine mammals from these activities. Seismic operations have the potential to harm marine mammals in close proximity to firing airgun arrays. Implementation of existing mitigations (NTL 2012-JOINT-G02), which include protected species observers and airgun shut-downs for whales in the exclusion zone, minimize impacts from these activities. Small numbers of marine mammals could be killed or injured by a collision with a service vessel; however, current BOEM and BSEE requirements and guidelines for vessel operation in the vicinity of protected species should minimize this risk (NTL 2012-JOINT-G01).

Other routine activities could impact marine mammals, although to a lesser degree. These activities include discharges, noise (i.e., vessel, aircraft, drilling, and production), and marine debris. Some industry-generated effluents are routinely discharged into offshore marine waters. Marine mammals may have some interaction with these discharges. Indirect effects to marine mammals through prey exposure to discharges are expected to be sublethal. Because OCS discharges are diluted and dispersed in the offshore environment, direct impacts to marine mammals are expected to be negligible. Noise including drilling, aircraft, and vessels noise, may affect marine mammals by eliciting a startle response or by masking other important biological sounds (e.g., conspecific calls). However, many of the industry-related sounds are believed to be out of, or on the limits of, marine mammal hearing, and the sounds are also generally temporary. Marine mammal ingestion of, and entanglement in, accidentally released industry debris is a concern. A marine mammal could suffer reduced feeding and reproductive success, and potential injury, infection, and death from entanglement in marine debris. Marine debris awareness training, instruction, and placards are required (NTL 2012-BSEE-G01) and are intended to greatly minimize the amount of debris that is accidentally lost overboard by offshore personnel.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of a noninjurious physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. It is estimated that 20-40 production structures resulting from a CPA proposed action would be removed using explosives. It is expected that structure removals would cause some behavioral changes and noninjurious physiological effects on marine mammals as a result of the implementation of the Bureau of Ocean Energy Management's NTL guidelines and regulations, and the NMFS's Observer Program for explosive removals. To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures.

Service-vessel round trips projected for a CPA proposed action (i.e., lease sale) are 94,000-168,000 trips (**Table 3-3**) over the life of a CPA proposed action. This equates to an average annual rate of 2,350-4,200 trips. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from marine mammals or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. It is not known whether toothed whales exposed to recurring vessel disturbance would experience stress or would be otherwise affected in a negative but less conspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Dolphins may approach vessels that are in transit to bow-ride. Vessel strike is the most common human-induced mortality factor for manatees and most manatees bear prop scars from contact with vessels. The rapid increase in exploration and development of petroleum resources in deep oceanic waters of the northern Gulf has increased the risk of OCS vessel collisions with sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales may be more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives.

Aircraft operations (helicopter take-off and landings) projected for a CPA proposed action are 696,000-1,815,000 operations (**Table 3-3**) over the life of a CPA proposed action. This equates to an average annual rate of 17,400-45,375 operations. The FAA Advisory Circular 91-36D (2004) encourages pilots to maintain an altitude of higher than 2,000 ft (610 m) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft (213 m) while in transit offshore and 500 ft (152 m) while working between platforms. In addition, guidelines and regulations issued by NMFS under the authority of the Marine Mammal Protection Act include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft (305 m) within 100 yd (91 m) of marine mammals. It is unlikely that marine mammals would be affected by routine OCS helicopter traffic operating at these altitudes. It is expected that about 10 percent of helicopter operations would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from and interrupt marine mammals nearby (depending on the activity of the animals). This temporary disturbance to marine mammals may occur as helicopters approach or depart OCS facilities if animals are near the facility and such disturbance is believed to be negligible.

A total of 168-329 exploration and delineation wells and 215-417 development wells are projected to be drilled as a result of a CPA proposed action. A total of 35-67 platforms are projected to be installed as a result of a CPA proposed action. These wells and platforms could produce sounds at intensities and frequencies that could be heard by marine mammals; however, most drilling and production noise is thought to be at frequencies below which most GOM marine mammals can hear. It is expected that noise from drilling activities would be relatively constant during the temporary duration of drilling. Baleen whales are apparently more dependent on low-frequency sounds than other marine mammals and may be species of concern regarding OCS-industry noise. However, all baleen whale species, except for the Bryde's whale, are considered extralimital or accidental in the GOM. There is a small population of Bryde's whales in the Gulf, although observations of this species have not occurred in the WPA (Waring et al., 2011). Thus, Bryde's whales and other baleen whale species are not likely to be subjected to OCS drilling and production noise in the CPA. The temporary and transient noise associated with drilling and production is not expected to produce more than negligible impacts on marine mammals.

Many types of materials, including plastics, are used during drilling and production operations. Some of this material is accidentally lost overboard where marine mammals could ingest it or become entangled in it. The result of ingesting some materials lost overboard could cause disease or death. Many of the plastics used by industry could withstand years of saltwater exposure without disintegrating or dissolving. An entangled marine mammal may suffer from acute impaired mobility that compromises its health quickly, or it may decline slowly from diminishing feeding and reproductive capability. Industry directives for reducing marine debris and BOEM's guidelines through its NTL for maintaining awareness of the problem and eliminating accidental loss continue to minimize industry-related trash in the marine environment.

Although there will always be some level of incomplete information on the effects from routine activities under a CPA proposed action on marine mammals, there is credible scientific information, applied using acceptable scientific methodologies, to support the conclusion that any realized impacts would be sublethal in nature and not in themselves rise to the level of reasonably foreseeable significant adverse (population-level) effects. Also, routine activities will be ongoing in the CPA proposed action area as a result of active leases and related activities. As of May 2012, there are 4,377 active leases in the CPA. Within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that routine activities from the preexisting OCS Program are significantly impacting marine mammal populations.

Summary and Conclusion

Some routine activities related to a CPA proposed action have the potential to have adverse, but not significant impacts to marine mammal populations in the GOM. Impacts from vessel traffic, structure removals, and seismic activity could negatively impact marine mammals; however, when mitigated as required by BOEM and NMFS, these activities are not expected to have long-term impacts on the size and productivity of any marine mammal species or population. Most other routine activities are expected to have negligible effects.

4.2.1.12.3. Impacts of Accidental Events

Accidental, unexpected events associated with a CPA proposed action could negatively impact marine mammals. Such impacts would primarily be the result of blowouts, oil spills, and oil-spill-response activities. Each of these is discussed below. Low-probability catastrophic events, similar to the DWH event, are analyzed in **Appendix B**.

Oil Spills

The impacts of an oil spill on marine mammals depends on many variables such as location and size of the spill, oil characteristics, weather and water conditions, time of year, and types of habitats affected, as well as the behavior and physiology of the marine mammals themselves (Johnson and Ziccardi 2006). The oil from a spill can adversely affect marine mammals by causing soft-tissue irritation, fouling of baleen plates, respiratory stress from the inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats. The long-term impacts to marine mammal populations are poorly understood but could include decreased survival and lowered reproductive success (Matkin et al., 2008). An oil spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making it more vulnerable to disease, parasitism, environmental contaminants, and/or predation. In either case, the impact can be significant to a marine mammal population or stock.

The range of toxicity and the degree of sensitivity to oil hydrocarbons on cetaceans are largely unknown. Most of the information on the effects of oil on marine mammals comes as a result of the *Exxon Valdez* oil spill and some limited exposure experiments (Geraci and St. Aubin, 1990).

The resident marine mammal species in the GOM include a baleen whale, toothed whales, and a sirenian. Baleen whales are particularly vulnerable to direct effects from fouling of baleen plates, which could impact feeding behavior. Marine mammals may have direct contact with oil by swimming through oil on the surface and/or subsurface. Surfacing behavior exposes skin, eyes, nares, and other mucous membranes to volatile hydrocarbons. This contact with oil could cause soft tissue damage to eye tissues potentially leading to ulcers, conjunctivitis, or blindness.

Fresh crude oil or volatile distillates release toxic vapors that, when inhaled, can lead to irritation of respiratory membranes, lung congestion, and pneumonia. Subsequent absorption of volatile hydrocarbons into the bloodstream may accumulate into such tissues as the brain and liver, causing neurological disorders and liver damage (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990). Toxic vapor concentrations just above the water's surface (where cetaceans draw breath) may reach critical levels for the first few hours after a spill, prior to evaporation and dispersion of volatile aromatic hydrocarbons and other light components (Geraci and St. Aubin, 1982). Young marine mammals could be poisoned by the absorption of oil through the mothers' milk (Australian Maritime Safety Administration, 2003a).

Studies by Geraci and St. Aubin (1982 and 1985) have shown that the cetacean epidermis functions as an effective barrier to many of the toxic substances found in petroleum. This barrier is a result of tight intercellular bridges, the vitality of the superficial cells, the thickness of the epidermis, and the lack of sweat glands and hair follicles (Geraci and St. Aubin, 1985). The cetacean epidermis is nearly impenetrable, even to the highly volatile compounds in oil, and when skin is breached, exposure to these compounds does not impede the progress of healing (Geraci and St. Aubin, 1985). Marine mammals are more likely to have dermal contact with weathered oil, which is more persistent but contains fewer of the toxic compounds found in fresh oil (Geraci and St. Aubin, 1990). Dolphins maintained at a captive site that were exposed to petroleum products initially exhibited a sharp decrease of food intake, along with excited behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a decrease of those blood parameters, changes in breathing patterns and gas metabolism, depressed nervous functions, and the appearance of skin injuries and burns (Lukina et al., 1996). Experiments with a harbor porpoise in similar conditions possibly resulted in aspiration pneumonia (Lukina et al., 1996).

Manatees concentrate their activities in coastal waters, often resting at or just below the surface, which may bring them in contact with spilled oil (St. Aubin and Lounsbury, 1990). Types of impacts to manatees from contact with oil include (1) asphyxiation due to inhalation of hydrocarbons, (2) acute poisoning due to contact with fresh oil, (3) lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum components into body tissues, (4) nutritional stress through damage to food sources, and (5) inflammation or infection and difficulty eating due to oil sticking to the sensory hairs around their mouths (Preen, 1989, in Sadiq and McCain, 1993, Australian Maritime Safety Administration, 2003a). Direct contact with discharged oil likely does not impact adult manatees' thermoregulatory abilities because they use blubber for insulation. Also, they exhibit no grooming behavior that would contribute to ingestion (USDOI, FWS, 2006). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food, although such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980; Reynolds, 1980). Spilled oil may also affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed.

There have been no experimental studies and only a handful of observations suggesting that oil has harmed any manatees (St. Aubin and Lounsbury, 1990), although for a population under pressure from other mortality factors (e.g., vessel strikes), even a localized incident could be significant (St. Aubin and Lounsbury, 1990). Oil spills that may occur from OCS energy activities that reach the coast or the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could further endanger local populations. The physiological costs of animals moving to colder waters to escape oiled areas may result in thermal stress that would exacerbate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990).

Trained, captive bottlenose dolphins exposed to oil could not detect light oil sheen but could detect thick dark oil based on visual, tactile, and presumably echolocation cues (Geraci et al., 1983; Smith et al., 1983). Studies of captive dolphins also showed that they completely avoided surfacing in slick oil after a few brief, initial tactile encounters. Reactions of free-ranging cetaceans to spilled oil appear varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive dolphins, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering the slick oil, which could increase their vulnerability to potentially harmful exposure to oil chemicals (Smultea and Würsig, 1991 and 1995). It is possible that some overriding behavioral motivation (such as feeding) induced dolphins to swim through the oil, that slick areas were too large for dolphins to feasibly avoid, or that bottlenose dolphins have become accustomed to oil due to the extent of oil-related activity in the Gulf (Smultea and Würsig, 1995). After the *Exxon Valdez* spill, killer whales did not appear to avoid oil; however, none were observed in heavier slicks of oil (Matkin et al., 1994). It is unknown whether animals in some cases are simply not affected by the presence of oil, or perhaps are even drawn to the area in search of prey organisms attracted to the oil's protective surface shadow (Geraci, 1990). The probable effects on cetaceans swimming through an area of oil would depend on a number of factors, including ease of escape from the vicinity, the health of the individual animal, and its immediate response to stress (Geraci and St. Aubin, 1985).

Indirect consequences of oil pollution on marine mammals include those effects that may be associated with changes in the availability or suitability of food resources (Hansen, 1992). Spilled oil can lead to the localized reduction, disappearance, or contamination of some prey species. Prey species, such as zooplankton, crustaceans, mollusks, and fishes may become contaminated by direct contact and/or by ingesting oil droplets and tainted food. Marine fishes are known to take up petroleum hydrocarbons from both water and food, although apparently do not accumulate high concentrations of hydrocarbons in tissues, and may transfer them to predators (Neff, 1990). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon, body-burden content is highest for benthic-feeding whales and pinnipeds. The potential is reduced for plankton-feeding whales and is lowest for fish-eating whales and pinnipeds (Würsig, 1990). An analysis of stomach contents from captured and stranded toothed whales suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). Dolphins feed on fish and/or squid, depending upon the species (Mullin et al., 1991). Depending on the spatial scale and magnitude of an oil spill, diminished prey abundance and availability may cause marine mammal predators to move to less suitable areas and/or consume less suitable prey.

The DWH event in Mississippi Canyon Block 252 and the resulting oil spill and related spill-response activities (including use of dispersants) have impacted marine mammals that have come into contact with oil and remediation efforts. According to the NMFS's website reports, within the designated DWH spill area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 Kogia spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NMFS, 2011a). All marine mammals collected either alive or dead were found east of the Louisiana/Texas border through Apalachicola, Florida. The highest concentration of strandings has occurred off eastern Louisiana, Mississippi, and Alabama, with a significantly lesser number off western Louisiana and western Florida (USDOC, NMFS, 2011a). Due to known low-detection rates of carcasses, it is possible that the number of deaths of marine mammals is underestimated (Williams et al., 2011). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses were related to the DWH oil spill. These stranding numbers are significantly greater than reported in past years; though it should be further noted that stranding coverage (i.e., effort in collecting strategies) has increased considerably due to the DWH event.

The blowout of the *Ixtoc I* offshore drilling rig in the Bay of Campeche, Mexico, on June 3, 1979, resulted in the release of 500,000 metric tons (140 million gallons) and the transport of this oil into the Gulf of Mexico (ERCO, 1982). Three million gallons of oil impacted Texas beaches (ERCO, 1982). According to the ERCO study, "Whether or not hypoxic conditions could, in fact, be responsible for area-wide reductions in [invertebrate] faunal abundance is unclear, however." Therefore, the effects from the Ixtoc spill on marine mammals in waters off Texas are largely unknown.

Information on the effects of spilled oil on marine mammals was gathered as a result of the 1989 *Exxon Valdez* tanker oil spill in Prince William Sound, Alaska. Of the marine mammal species affected by this spill, the killer whale is the only species to also occur in the GOM. The "2010 Injured Resources & Services Update" in the *Exxon Valdez* Oil Spill Restoration Plan provided by the *Exxon Valdez* Oil Spill Trust Council determined, although still circumstantial, that declines in killer whale numbers (primarily the AB and AT1 populations) immediately following the spill were likely a result of the inhalation of petroleum or petroleum vapors and possible eating of contaminated fish or oiled harbor seals. Twenty years later, the *Exxon Valdez* Oil Spill Trust Council determined these populations to still be recovering (*Exxon Valdez* Oil Spill Trust Council, 2010; Matkin et al., 2008).

The potential effects associated with a low-probability large spill may be more severe than a smaller accidental spill. The effect could potentially contribute to more significant and longer-lasting impacts that could include mortality and longer-lasting chronic or sublethal effects. **Appendix B** discusses, in general, the magnitude and duration of effects possible if the low-probability, large-volume spill were to occur in the Gulf of Mexico.

Spill-Response Activities

Spill-response activities that may impact marine mammals include increased vessel traffic, use of dispersants, and remediation activities (e.g., controlled burns, skimmers, boom, etc.). The increased human presence after an oil spill (e.g., vessels) would likely add to changes in behavior and/or distribution, thereby potentially stressing marine mammals further and perhaps making them more vulnerable to various physiologic and toxic effects of spilled oil. In addition, the large number of response vessels could place marine mammals at a greater risk of vessel collisions, which could cause fatal injuries. Manatees are particularly vulnerable to vessel collisions that may result from increased vessel traffic. Approximately 94 percent of human-caused manatee mortalities in Florida were attributed to collisions with watercraft (Florida Fish and Wildlife Commission, Fish and Wildlife Research Institute, 2010a). Vessel noise would also increase as a result of increased vessel activity and could result in behavioral changes in some individuals.

Spill-response activities include the application of dispersant chemicals to the affected area. Dispersant chemicals are designed to break oil on the water's surface into minute droplets, which then break down in seawater. Essentially nothing is known about the effects of oil dispersants on cetaceans, except that removing oil from the surface would reduce the risk of contact and render it less likely to adhere to skin, baleen plates, or other body surfaces (Neff, 1990). The acute toxicity of most oil dispersant chemicals is considered to be low relative to the constituents and fractions of crude oil and refined products, and studies have shown that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil (Wells, 1989). Varieties of aquatic organisms readily accumulate and metabolize surfactants from oil dispersants. Enzymatic hydrolysis of the surfactant yields hydrophilic and hydrophobic components. The former probably are excreted via the gills and kidneys, whereas the latter accumulate in the gallbladders of fish and are excreted very slowly (Neff, 1990). Metabolism of surfactants is thought to be rapid enough that there is little likelihood of food chain transfer from marine invertebrates and fish to predators, including marine mammals (Neff, 1990). Impacts from dispersants are unknown but may be irritants to tissues and sensitive membranes (NRC, 2005a). One assumption concerning the use of dispersants is that the chemical dispersion of oil will considerably reduce the impacts to marine mammals, primarily by reducing their exposure to petroleum hydrocarbons (French-McCay, 2004; NRC, 2005a). However, the impacts to marine mammals from chemical dispersants could include nonlethal injury (e.g., tissue irritation and inhalation), long-term exposure through bioaccumulation, and potential shifts in distribution from some habitats.

Remediation activities that could impact marine mammals include the use of skimmers, booms, and controlled burns. Impacts from skimmers could be through capture and/or entrainment. Booming operations could potentially impact marine mammals, particularly manatees, as they are known to explore and interact with objects in their environment (Hartman 1979). Lines used to anchor booms are more likely than the boom itself to impact manatees if the booms are deployed in manatee habitat. Controlled burns could impact marine mammals if they were in the burning oil; however, it is expected that animals would avoid the area once it is ignited. In both skimming and controlled burning activities, the use of trained observers is common and reduces the likelihood of impacts to marine mammals.

Proposed Action Analysis

Marine mammals occur in the inshore, coastal, and oceanic waters of the GOM and could be impacted by accidental spills resulting from operations associated with a CPA proposed action. The greatest diversity and abundance of cetaceans inhabiting the GOM is found in its oceanic and OCS waters. Individual cetaceans are not necessarily randomly distributed in the offshore environment, but are instead prone to forming groups of varying sizes. In some cases, several species may be found aggregating in the same area. Large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (i.e., days, weeks, months), pose an increased likelihood of impacting cetacean populations inhabiting these waters. Based on abundance estimates and a hypothetical spill surface area, spills occurring in these waters could impact more species and more individuals than coastal spills, potentially impacting coastal marine mammal species.

The mean number and various sizes of estimated spills occurring in OCS offshore waters in the CPA is presented in **Table 3-12**. The possibility of a spill >10,000 bbl in the CPA is estimated to be up to one spill during the 40-year period of a CPA proposed action. For spills ≥1,000 bbl and >10,000 bbl, the potential causes, volumes, and probabilities associated with a CPA proposed action are presented in **Chapter 3.2.1 and Table 3-12**. **Chapter 4.2.1.12.3** summarizes BOEM's information on the risk to marine mammals analyzed in this EIS from oil spills and oil slicks that could occur as a result of a CPA proposed action. The probabilities of oil spills (≥1,000 bbl) occurring and contacting within 10 and 30 days the manatee habitats as a result of a CPA proposed action are presented seasonally in **Figure 3-13**.

The probability of an individual marine mammal encountering an oil slick from a single, small spill is extremely low. However, several factors increase the probability of marine mammal/oil-spill contact, including (1) marine mammals often travel long distances in the Gulf, increasing the geographic areas of potential impact; (2) marine mammals are relatively long-lived and have many years during which they may be exposed; (3) the life of a CPA proposed action also means many years for an impact to occur; and (4) some spills would be larger increasing the area of potential impact. It is impossible to know precisely which cetacean species, population, or individuals will be most impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to predicting when and where oil spills will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with a CPA proposed action and the distribution of marine mammals in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers.

Chapter 3.2.1 details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse, cetaceans may be exposed via the waters that they inhabit, as well as via the prey they consume. For example, tarballs may be consumed by marine mammals and by other marine organisms that are eaten by marine mammals.

Although marine mammals may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern Gulf will likely be exposed to residuals of spilled oil throughout their lifetime.

The NMFS believes that a small number of listed species will experience adverse effects as the result of exposure to a large oil spill or ingestion of accidentally spilled oil over the lifetime of a CPA proposed action. As per the 2007 Biological Opinion, NMFS stated that spilled oil could cause nonlethal takes of sperm whales over the 40-year lifetime of a CPA proposed action. However, NMFS did not include an incidental take statement for the incidental take of listed species due to oil exposure. Incidental take, as defined at 50 CFR 402.02, refers only to takings that result from an otherwise lawful activity. The Clean Water Act (33 U.S.C. 1251 *et seq*.), as amended by the Oil Pollution Act of 1990 (33 U.S.C. 2701 *et seq*.), prohibits discharges of harmful quantities of oil, as defined at 40 CFR 110.3, into waters of the United States. Therefore, even though the Biological Opinion considered the effects on listed species by oil spills, those takings that would result from an unlawful activity (i.e., oil spills) are not specified in the Incidental Take Statement and have no protective coverage under Section 7(o)(2) of the Endangered Species Act.

Summary and Conclusion

Accidental events related to a CPA proposed action have the potential to have adverse, but not significant impacts to marine mammal populations in the GOM. Accidental blowouts, oil spills, and spill-response activities may impact marine mammals in the GOM. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents; characteristics of spilled oil; spill-response capabilities and timing; and various meteorological and hydrological factors.

Oil spills may cause chronic (long-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals. Long-term effects include (1) decreases in prey availability and abundance because of increased mortality rates, (2) change in age-class population structure because certain year-classes were impacted more by oil, (3) decreased reproductive rate, and (4) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). The effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in marine mammal behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects.

Even after the spill is stopped, oilings or deaths of marine mammals would still occur due to oil and dispersants persisting in the water, past marine mammal/oil or dispersant interactions, and ingestion of contaminated prey. The animals' exposure to hydrocarbons persisting in the sea may result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) and some soft tissue irritation, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats.

On July 30, 2010, BOEMRE reinitiated ESA Section 7 Consultation on the previous 2007-2012 Multisale EIS with both FWS and NMFS. This request was made as a response to the DWH event and is meant to comply with 50 CFR 402.16, "Re-initiation of formal consultation." The BOEM is acting as lead agency in the reinitiated consultation, with BSEE involvement. Consultation is ongoing at this time. As BOEM moves forward with this Five-Year Program (2012-2017), BOEM and BSEE have developed an interim coordination and review process with NMFS and FWS for specific activities leading up to or resulting from upcoming lease sales. The purpose of this coordination is to ensure that NMFS and FWS have the opportunity to review postlease exploration, development and production activities prior to BOEM approval to ensure that all approved plans and permits contain any necessary measures to avoid jeopardizing the existence of any ESA-listed species or precluding the implementation of any reasonable and prudent alternative measures. This interim coordination program remains in place while formal consultation and the development of a Biological Opinion are ongoing.

4.2.1.12.4. Cumulative Impacts

The cumulative analysis considers past, ongoing, and foreseeable future human and natural activities that may occur and adversely affect marine mammals in the same general area that may be affected by a CPA proposed action. The major potential impact-producing factors affecting protected marine mammals in the GOM as a result of cumulative OCS energy-related activities include marine debris, contaminant spills and spill-response activities, vessel traffic, noise, seismic surveys, and explosive structure removals. Non-OCS energy-related activities that may affect marine mammal populations include vessel traffic and related noise (including from commercial shipping, research vessels), military operations, commercial fishing, pollution, scientific research and natural phenomena. Specific types of impact-producing factors considered in this cumulative analysis include noise from numerous sources, pollution, habitat degradation, vessel strikes, and ingestion and entanglement in marine debris.

The major impact-producing factors relative to a CPA proposed action are described in **Chapter 4.2.1.12.2**. Chapters providing supportive material for the marine mammals analysis include **Chapters 4.2.1.12.1** (description of marine mammals), **3.1.1.2** (exploration), **3.1.1.3** (development and production), **3.1.1.6** (offshore and coastal noise), **3.1.2.1** (coastal infrastructure), and **3.2.1** (spills). This Agency completed a Programmatic EA on G&G permit activities in the GOM (USDOI, MMS, 2004). This Programmatic EA includes a detailed description of the seismic surveying technologies, energy output, and operations, and it is hereby incorporated by reference.

Noise in the ocean has become a worldwide topic of concern, particularly in the last decade. The GOM is a very noisy place, and noise in the Gulf comes from a broad range of sources. Virtually all of the marine mammal species in the Gulf have been exposed to OCS-industrial noise due to the rapid advance into GOM deep oceanic waters by the oil and gas industry in recent years; whereas, 20 years ago, the confinement of industry to shallower coastal and continental shelf waters generally only exposed two species of marine mammals (the bottlenose dolphin and the Atlantic spotted dolphin) to industry activities and the related sounds. Most marine mammal species in the Gulf, and particularly the deepwater mammals, rely on echolocation for basic and vital life processes including feeding, navigation, and conspecific and mate communication. Noise levels that interfere with these basic mammal capabilities could have impacts on individuals and populations. The OCS-industry operations contribute noise to the marine environment from several different operations. As noted in **Chapter 4.2.1.12.2**, it is believed that most of the industry-related noise is at lower frequencies than is detectable or in the sensitivity range of most of the GOM marine mammal species. However, most of the information on marine mammal hearing is inferred, and there are reports of species reacting to sounds that were not expected to be audible.

Industry noise sources include seismic operations, fixed platforms and drilling rigs, drilling ships, low-flying aircraft, vessel traffic, and explosive operations, particularly for structure removal. **Chapter 3.1.1.6** discusses the expected sources of many of these impacts for the OCS Program, as well as the expected sources from past, present, and future OCS-industry operations. Many other sources also contribute to the overall noise in the GOM. The dominant source of human sound in the sea is ship noise (Tyack, 2008). Both the noise from the vessel's operation as well as the potential for ship strikes could potentially impact marine mammals. The primary sources of vessel noise are propeller cavitations, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). The intensity of noise from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladed vessels. The GOM is a very active shipping area and supertankers are very common. Of the 10 busiest ports in the United States, 7 are located in the Gulf of Mexico (USEPA, 2011e). Other groups such as the military (U.S. Navy and USCG) and other Federal agencies (USEPA, COE, and NMFS), dredges, commercial fishermen, and recreational boaters operate vessels and contribute to the ambient noise in the Gulf. Industry service boats are numerous and are expected to make 2, 350-4,200 round trips in the CPA per year. Service vessels are a large contribution to ship noise; however, service boats are not nearly as large or as loud as commercial shipping vessels. Also, service vessels travel rapidly and, thus, an area is ensonified for only a brief time.

The BOEM and BSEE issued NTL 2012-JOINT-G01, which provides guidance for vessel strike avoidance and reporting. This guidance should minimize the chance of marine mammals being subject to the increased noise level of a service vessel in very close proximity. Aircraft overflights are another source of noise and can cause startle reactions in marine mammals, including rapid diving, change in travel direction, and dispersal of marine mammal groups. With approximately a million helicopter take offs/landings expected per year from activity related to past, proposed, and future lease sales, OCS-industry activity contributes greatly to this noise source. Although air traffic well offshore is limited, the military maintains 11 military warning areas and 6 water test areas in the Gulf (**Figure 2-2**). Some commercial fisheries include aerial surveillance. Scientific research aerial surveys are occasionally scheduled over the GOM. Commercial and private aircraft also traverse the area. Flight level minimum guidelines from NMFS and corporate helicopter policy should help mitigate the industry-related flight noise, although lower altitudes near shore and as the helicopter lands and departs from rigs could impact marine mammals in close proximity to the structures or shore bases. Occasional overflights are not expected to have long-term impacts on marine mammals.

The OCS-industry drilling impacts are discussed in **Chapter 3.1.1**. State oil and gas activities (**Chapter 3.3.2)** also create drilling and associated noise, particularly in Texas and Louisiana State waters. Although much of the focus is on industry operations in deep water, there is still interest and activity in more shallow and even coastal waters for oil and gas production. Similarly, explosive structure removals put considerable sound into the ocean, and these can occur in Federal or State waters. The COE also engages in some explosive and pile-driving operations that create loud but temporary noise. Such COE activities are consulted on with NMFS, and mitigations are included, often similar to the mitigations employed by BOEMRE in consultation with NMFS. In 2005, this Agency petitioned NMFS for incidental-take regulations under the MMPA to address the potential injury and/or mortality of marine mammals that could result from the use of explosives during decommissioning activities. Similarly, this Agency initiated ESA Section 7 Consultation efforts with NMFS to cover potential explosive-severance impacts to threatened and endangered species such as sperm whales (and sea turtles). The ESA Consultation was completed in August 2006 and the final MMPA rule was published in June 2008. The mitigation, monitoring, and reporting requirements from the current ESA Biological Opinion/Incidental Take Statement and MMPA regulations mirror one another and allow explosive charges up to 500 lb (227 kg), internal and external placement, and both above-mudline and below-mudline detonations. The BOEMRE has issued "Decommissioning Guidance for Wells and Platforms (NTL 2010-G05) to offshore operators. These guidelines specify and reference mitigation requirements in the current ESA and MMPA guidance and require trained observers to watch for protected species (sea turtles and marine mammals) in the vicinity of the structures to be removed.

Seismic exploration is the source of the loudest, and perhaps most controversial, OCS-industry activity. Details on seismic impacts on marine mammals are given in **Chapter 4.2.1.12.2,** and complete information is included in the G&G Programmatic EA (USDOI, MMS, 2004). Seismic exploration is an integral part of oil and gas discovery, development, and production in the GOM. With technical advances that now allow extraction of petroleum from the ultra-deep areas of the Gulf, seismic surveys are routinely conducted in virtually all water depths of the western GOM, including the deep habitat of the endangered sperm whale. Noise and acoustic disturbance have been topics of great debate in the last several years, and there is general agreement that the use of sonar, particularly by the military, has in some cases been associated with very severe impacts to certain species of marine mammals in recent years. Seismic airgun sounds are often incorrectly lumped with sonar noise as sources of marine mammal disturbance. Although there are anecdotal associations between mammal disturbance and airgun noise, most of those have other factors occurring at the same time (i.e., sonar use) that may be responsible for any adverse impacts. However, seismic surveys have the potential to impact marine mammals. In 2003, NMFS published a notice of receipt of application for an incidental take authorization from this Agency, requesting comments and information on taking marine mammals incidental to conducting oil and gas exploration activities in the GOM (68 FR 9991). In 2004, NMFS published a notice of intent to prepare an EIS, notice of public meetings, and request for scoping comments, for the requested authorizations (69 FR 67535). In April 2011, NMFS received a revised complete application from BOEMRE requesting an authorization for the take of marine mammals incidental to seismic surveys on the OCS in the GOM (76 FR 34657). The National Marine Fisheries Service's EIS has not been completed at this time. In response to terms and conditions in the NMFS Biological Opinion for Lease Sale 184 in 2002, this Agency developed mitigations for the seismic industry that require, among other things, dedicated marine mammal observers aboard all seismic vessels, gradual ramp-up of the airgun array, and shutdowns of airgun firing if a whale gets within 500 m (1,640 ft) of an active airgun array. Although shutdowns are not extremely frequent, they do occur. Also, as reported in **Chapter 4.2.1.12.1**, current research by

BOEM and partners did not detect avoidance of seismic vessels or airguns by sperm whales. Although that finding could be interpreted several ways, it is likely that the whales, which appear to generally remain in the northern Gulf year round, are habituated to seismic operations. Since the sperm whale is the only endangered cetacean (whale or dolphin) in the GOM, most of the research has focused on that species. However, other species may react very differently to seismic disturbances. Even with additional ongoing research, such changes in species abundance and distribution due to seismic disturbances would likely be very difficult to establish on a small scale. For the sperm whale, the most recent abundance was estimated to be 1,665 individuals (Waring et al., 2011). Research has shown that sperm whales are distributed throughout the deeper waters of the northern GOM, not primarily in the Mississippi Canyon as previously thought. With seismic surveys frequently conducted in the CPA (and WPA), it is likely that there are few naive sperm whales (those that have not been exposed to seismic sound) in the northern Gulf. The GOM sperm whales have generally been smaller than sperm whales in other areas, and genetic research indicates a distinct stock or population that is almost exclusively females and immature males. Observations of adult males are uncommon in the GOM (<10), yet calves are seen regularly. Reproduction is occurring in a highly industrialized environment, although stress, particularly at the individual animal level, is difficult to observe. Over the long term, stress to a population could cause very significant adverse effects, including disease, reproductive failure, and population decline. Tools such as the satellite tag (s-tag) that allow the tracking of individual whales, and sometimes several individuals in a group, over the span of weeks and months, may provide information on behavioral changes, as well as learning what "typical" whale behavior is.

Pollution of marine waters is another potentially adverse impact to marine mammals in the GOM. Information on drilling fluids and drill cuttings and produced waters that would be discharged offshore is discussed in **Chapter 3.1.1.4**. Effluents are routinely discharged into offshore waters and are regulated by the U.S. Environmental Protection Agency's NPDES permits. Marine mammals may periodically be exposed to these discharges. Direct effects to marine mammals are expected to be sublethal. Indirect effects via food sources are not expected because of dilution and dispersion of offshore operational discharges. Another OCS-industry form of pollution is accidental oil spills. Impacts of these accidental events to marine mammals are discussed in **Chapter 4.2.1.12.3**.

In 2010, the DWH event in Mississippi Canyon Block 252 occurred and the resulting oil spill and related spill-response activities (including use of dispersants) have impacted marine mammals that have come into contact with oil and remediation efforts. According to the NMFS website reports on stranded marine mammals during and after the DWH event, 171 marine mammals (the majority of which were deceased) have been collected as of April 20, 2011. All marine mammals collected either alive or dead were found east of the Louisiana/Texas border. Advances in oil-spill prevention technologies and safety requirements should greatly reduce the amount of oil that enters the marine environment accidentally. However, there is still the potential for an oil spill. Many small spills are estimated as a result of the OCS Program. The probability of a spill decreases as the projected size of the spill increases. Marine mammals are likely to contact oil in the marine environment over their life span. However, because of dilution and weathering, such contact is expected to be sublethal in most situations. Indirect effects from the exposure of prey species to oil are also expected to be sublethal. Oil in the ocean can and does come from sources other than industry operations. Ships are known to illegally pump oily bilges into the environment. Mechanical failure on any type of vessel can lead to an oil spill, though these are usually small. Even natural seeps on the floor of the GOM can result in an oil slick or sheen on the surface (NRC, 2003).

Pollution in the ocean comes from many point and nonpoint sources, and the GOM is certainly no exception. The drainage of the Mississippi River results in massive amounts of chemicals and other pollutants being constantly discharged into the Gulf. The zone of hypoxia on the Louisiana-Texas shelf is one of the largest areas of low oxygen in the world's coastal waters (Murray, 1997). Since most of the marine mammals in the Gulf are oceanic deepwater dwellers, the impact of coastal and run-off pollution is greatly minimized as a result of dilution and dispersal. Primarily, the bottlenose dolphin and the manatee are most at risk for nearshore pollution. Bottlenose dolphins have been reported having very high levels of contaminants, including heavy metals, in tissue samples. Coastal dolphins generally have higher contaminant levels than offshore dolphins, which supports the dilution and dispersal theory. Prey species also affect the influence of pollution on marine mammals. Biomagnification in fish results in the generally higher contaminant levels of fish-eating marine mammals over squid-eating species. Manatees are herbivores, but pollution and habitat degradation may impact the manatee. Manatees are exposed to pesticides by ingesting aquatic vegetation containing concentrations of these compounds. The propensity of manatees to aggregate at industrial and municipal outfalls also may expose them to high concentrations of contaminants. Antifouling bottom paint on the hulls of boats has been linked to the release of contaminants. For coastal dolphins and especially manatees that are very well known to frequent marinas and that scratch on the hulls of vessels, areas with high concentrations of vessels may have extremely polluted waters.

Marine debris is a serious concern in the ocean environment. Plastics in particular, and from many different sources, pose a threat to the environment and a serious threat to marine mammals. Ingestion of plastic can cause a digestive blockage and ultimately death for a marine mammal. Entanglement in anything from 6-pack rings to strapping bands to discarded monofilament nets can result in injury and very slow death for marine mammals. A wide variety of debris is commonly observed in the Gulf and it comes from both terrestrial and marine sources. Accidental release of debris from OCS activities is known to occur offshore, and ingestion of, or entanglement in, discarded material could injure or kill cetaceans. Sheavely (2007) reports that as much as 49 percent of marine debris is considered land-based. The offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore in 1995 (Miller et al., 1995). Since that time, industry has implemented waste management programs and has greatly improved waste handling. More efficient gear packaging and better galley practices have significantly reduced the amount of waste generated offshore. The BSEE prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.300). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. The BSEE provides information on marine debris and awareness and requires training of all OCS personnel through the "Marine Trash and Debris Awareness and Elimination" NTL (NTL 2012-BSEE-G01).

Vessel strikes are a serious threat to marine mammals in the GOM. A collision between a marine mammal and a ship would result in injury and likely death. The increase in vessel traffic due to a CPA proposed action would increase the probability of a vessel strike and the injury or death of some animals. The increased vessel traffic may alter behavior of marine mammals by avoidance, displacement, or attraction to the vessel. However, those effects are expected to be short-term. Industry-related vessels are only a part of the shipping activity in the Gulf. All manner of commercial shipping vessels, commercial fishing vessels, military ships, research ships, recreational craft, and others are always present in the Gulf. The BOEM and BSEE issued NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which provides guidance for vessel strike avoidance and reporting in order to minimize harassment of mammals by vessels approaching too closely. It also provides for the reporting of injured or dead protected species. Although OCS vessel traffic would be a major component of the cumulative vessel impacts, professional piloting and regulatory guidelines would minimize the impact of the OCS segment of vessel traffic. Some factions of the boating public, mainly recreational fishermen and boaters, create adverse impacts by paying too much attention rather than not enough. Although most of these interactions are because of ignorance rather than malicious intent, reports of harassment, inappropriate feeding, and even attempting to swim with marine mammals are common. Dolphins have been injured and killed after becoming accustomed to being fed by humans. Animals become sick from eating the "food" that people throw. Very close approaches by boats are likely major causes of stress in marine mammals, as is chasing and following. The presence of industry structure (platforms) in the deep waters of the Gulf may indirectly be encouraging these interactions. Recreational fishing vessels go much farther out to get to the improved fishing at OCS energy structures. This also puts these vessels in oceanic marine mammal waters. Service-vessel crews that keep attention on the water and that intentionally avoid marine mammals should not pose a threat to marine mammal populations.

Other activities may have adverse effects on marine mammals. Occasionally, numbers of marine mammals strand, either alive or already dead. Die-offs happen infrequently but can seriously deplete small, discreet stocks. The causes of die offs are not always well known and vary by event. Some appear to be triggered by natural events (i.e., unusually cold weather) but others are suspected to at least be indirectly caused by pollution of various contaminants. Exposure to certain compounds may weaken the natural immunity of marine mammals and make them susceptible to viruses and diseases that would normally not affect them. Certain viruses are being observed more frequently than in the past. On

December 13, 2010, NMFS declared a UME for cetaceans (whales and dolphins) in the GOM. An UME is defined under the MMPA as a "stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response." Evidence of the UME was first noted by NMFS as early as February 2010. As of April 18, 2012, a total of 723 cetaceans have stranded since the start of the UME, with a vast majority of these strandings involving premature, stillborn or neonatal bottlenose dolphins between Franklin County, Florida, and the Louisiana/Texas border (within the CPA). More detail on the UME can be found on NMFS's website (USDOC, NMFS, 2012a).

It is unclear at this time whether the increase in strandings is related partially, wholly, or not at all to the DWH event. According to the NMFS website referenced above, which is the only publicly available source of information at this time on the UME, evidence of the UME was first documented by NMFS as early as February 2010, several months prior to the DWH event. The NMFS has also documented an additional 11 UME's that have been previously declared in the GOM for cetaceans since 1991. However, the current data **Table 4-5** also show a marked increase in strandings during the DWH-event response and afterwards. According to the website, NMFS considers the investigation into the cause of the UME and the potential role of the DWH event to be "ongoing and no definitive cause has yet been identified for the increase in cetacean strandings in the northern Gulf in 2010 and 2011." It is therefore unclear whether increases in stranded cetaceans during and after the DWH-event response period are or are not related to impacts from the DWH event and will likely remain unclear until NMFS completes its UME and NRDA evaluation processes.

The Gulf has very little fishery interaction with marine mammals, compared with other areas. However, marine mammals can be injured or killed by commercial fishing gear. Mammals can either get caught on longline hooks or can be entrained into a net by a shrimp boat or groundfish vessel. There is also the chance of entanglement by lines from crab traps to buoys. Gillnets, which have now been banned in many places around the Gulf, have been reported to take marine mammals. Reports of these impacts are uncommon.

Scientific research can impact marine mammal species. The BOEM has conducted numerous marine mammal research cruises, and permitted activities have included tagging and biopsy sampling. Protocols are always in place to keep the mammals safe, but some of the research techniques do involve harassment and possible stress to the animal. Scientific seismic studies could have the same impact with the same very loud noise as industry seismic work. Scientific groundfish or shrimp cruises can entrap a dolphin in a net just as commercial fisheries can. In 2011, a scientific cruise that was associated with NRDA killed six pantropical spotted dolphins (*Stenella attenuata*) while sampling fish with nets. Scientific aerial surveys are also periodically conducted in the Gulf, and aircraft can startle mammals. Circling pods for identification may stress multiple individuals in a pod. Such marking techniques as freeze branding were used in the past to do mark-recapture studies. This required the live capture and branding of dolphins. Both the Navy and the public-display industry took bottlenose dolphins from the Gulf in years past. A moratorium on live captures has been in effect for several years, as captive breeding programs have become successful enough to provide dolphins for aquariums and zoos.

Lastly, tropical storms and hurricanes are normal occurrences in the Gulf and along the coast. Generally, the impacts have been localized and infrequent. However, during the past 7 years, the GOM has been hit extremely hard by very powerful hurricanes. Few areas of the coast have not suffered some damage in 2004 and 2005, and activities in the Gulf have also been severely impacted. In 2004, Hurricane Ivan took a large toll on oil and gas structures and operations in the Gulf and caused widespread damage to the Alabama-Florida Panhandle coast. In 2005, Hurricanes Katrina, Rita, and Wilma reached Category 5 strength in the GOM, and these hurricanes were followed in 2008 by Hurricanes Gustav and Ike. These storms caused damage to all five of the Gulf Coast States and damage to structures and operations both offshore and onshore. The actual impacts of these storms on the animals in the Gulf, and the listed species and critical habitat in particular, have not yet been determined and, for the most part, may remain very difficult to quantify. Examples of other impacts that may have affected species include oil, gas, and chemical spills from damaged and destroyed structures and vessels (although no major oil spills were reported, several lesser spills are known to have occurred), increased trash and debris in both offshore and inshore habitats, and increased runoff and silting from wind and rain. Not only are the impacts themselves difficult to assess, but the seasonal occurrence of impacts from hurricanes is also impossible to predict. Generally, the far offshore species and the far offshore habitat are not expected to have been severely affected in the long term. However, species that occupy more nearshore or inshore habitats may have suffered more long-term impacts.

Unavailable information on the effects to marine mammals from the UME and DWH event (and thus changes to the marine mammal baseline in the affected environment) makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to marine mammals. For marine mammals occurring in the CPA, the Bureau of Ocean Energy Management cannot rule out that incomplete or unavailable information may be essential to a reasoned choice among the alternatives for this EIS (including the No Action and Action Alternatives). Relevant data on the status of marine mammal populations after the UME and DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Further, there are already scientific processes in place through NRDA and UME responses to investigate these remaining questions. The NMFS has jurisdiction for the investigation of marine mammal strandings and has only released raw data on stranding numbers to date. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

Nevertheless, as of May 2012, there are 4,377 active leases in the CPA with ongoing (or the potential for) exploration, drilling and production activities. In addition, non-OCS energy-related activities (e.g., fishing, military activities, and scientific research) will continue to occur in the CPA irrespective of a CPA proposed action. The potential for effects from changes to the affected environment (post-DWH), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this EIS. Impacts on marine mammals from either smaller accidental events or low-probability catastrophic events would remain the same.

Summary and Conclusion

Cumulative impacts on marine mammals are expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources (Harvey and Dahlheim, 1994). Disturbance (noise from vessel traffic and drilling operations) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal (Harvey and Dahlheim, 1994). The net result of any disturbance will depend upon the size and percentage of the population likely to be affected, the ecological importance of the disturbed area, the environmental and biological parameters that influence an animal's sensitivity to disturbance and stress, or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). As discussed in **Appendix B**, a low-probability catastrophic event could have population-level effects on marine mammals.

The effects of a CPA proposed action, when viewed in light of the effects associated with other past, present, and reasonably foreseeable future activities, may result in greater impacts to marine mammals than before the DWH event; however the magnitude of those effects cannot yet be determined. Nonetheless, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTL's, to minimize these potential interactions and impacts. The operator's reaffirmed compliance with NTL 2012-JOINT-G01 ("Vessel Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2012-BSEE-G01 ("Marine Trash and Debris Awareness and Elimination"), as well as the limited scope, timing, and geographic location of a CPA proposed action, would result in negligible effects from the proposed drilling activities on marine mammals. In addition, NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimizes the potential of harm from seismic operations to marine mammals. These mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source. Therefore, no significant cumulative impacts to marine mammals would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area.

Within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting marine mammal populations. Therefore, in light of the above analysis for a CPA proposed action and its impacts, the incremental effect of a CPA proposed action on marine mammal populations is not expected to be significant when compared with non-OCS energy-related activities.

4.2.1.13. Sea Turtles

Of the seven or eight extant species of sea turtles, five are known to inhabit the waters of the GOM (Pritchard, 1997): the leatherback, green turtle, hawksbill, Kemp's ridley, and loggerhead (**Table 4-6**). These five species are all highly migratory, and no individual members of any of the species are likely to be year-round residents of the analysis area. Individual animals will make migrations into nearshore waters as well as other areas of the North Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea.

Natural disturbances such as hurricanes can cause significant destruction of nests and topography of nesting beaches (Pritchard, 1980; Ross and Barwani, 1982; Witherington, 1986). Tropical storms and hurricanes are a normal occurrence in the GOM and along the coast. Generally, the impacts have been localized and infrequent. Few areas of the Gulf Coast have not suffered some damage in 2004, 2005, and 2008, and activities in the Gulf of Mexico have also been severely impacted. Some impacts, such as loss of beach habitat, are known to have occurred and will impact sea turtles that would have used those areas for nesting beaches. Increases or decreases in beach armoring and other structures may impact all nesting sea turtles in the areas affected. Hurricanes and tropical activity may temporarily remove some of these barriers to suitable nesting habitat. However, rebuilding may replace and expand the structures, magnifying the impact of natural habitat loss with manmade habitat loss.

Global climate change could result in numerous and severe impacts to sea turtles. Rising sea levels could further diminish available nesting beach habitat. Changing ocean temperatures may alter distribution patterns for sea turtle prey (i.e., jellyfish for leatherbacks). This could impact adult survivability as well as nesting success. Warming temperatures may change the sex ratios of hatchlings as sex is determined by nest temperature. These are just a few examples of potential effects of global climate change. Although extremely difficult to predict, this is a topic of growing concern.

4.2.1.13.1. Description of the Affected Environment

Five sea turtles are known to inhabit the waters of the GOM (Pritchard, 1997): the leatherback (endangered, listed June 2, 1970); green turtle (breeding colony populations in Florida and on the Pacific Coast of Mexico are listed as endangered; all others are listed as threatened; listed July 28, 1978); hawksbill (endangered, listed June 2, 1970); Kemp's ridley (endangered, listed December 2, 1970); and loggerhead (threatened, listed July 28, 1978). These five species are all highly migratory (**Table 4-6**). Individual animals will make migrations into nearshore waters as well as other areas of the North Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea. Although migratory, these migration patterns are not well defined. All five species of sea turtles found in the GOM have been federally listed as endangered or threatened since the 1970's. There is currently no critical habitat designated in the GOM or along the Gulf Coast. On February 17, 2010, NMFS and FWS were jointly petitioned to designate critical habitat for Kemp's ridley sea turtles for nesting beaches and for marine habitats in the GOM and Atlantic Ocean. The NMFS is currently reviewing the petition.

In August 2007, FWS and NMFS published 5-year status reviews for federally listed sea turtles in the GOM (USDOC, NMFS and USDOI, FWS, 2007a-e). A 5-year review is an ESA-mandated process that is conducted to ensure the listing classification of a species as either threatened or endangered is still accurate. Both agencies share jurisdiction for federally listed sea turtles and jointly conducted the reviews. After reviewing all of the best scientific and commercially available information and data, the agencies' biologists recommended that the current listing classification for the five sea turtle species remain unchanged.

Natural phenomenon, such as tropical storms and hurricanes, are impossible to predict, but they will occur in the GOM. Generally, the offshore species and the offshore habitat are not expected to be severely affected in the long term. However, species that occupy more nearshore habitats and those that use nearshore habitats for nesting may suffer more long-term impacts. Several major hurricanes have hit the Gulf Coast in the last several years. Storm impacts, including loss of nesting habitat, increased marine debris, and spilled pollutants, can be detrimental to sea turtles. Impacts from the storms to nesting activity can be hard to assess. Hurricane Katrina in 2005 decimated the northern Gulf Coast, including the Chandeleur Islands off of Louisiana/Mississippi. This barrier island chain was a significant loggerhead nesting site (Lohoefener et al., 1990). Very little area that would be suitable for nesting remains above sea level. Subsequent storms have delayed any rebuilding of the Chandeleur Islands. Hurricane Gustav in 2008 also occurred in areas used by sea turtles for nesting. Both the washing away of sand beaches and the proliferation of debris on nesting beaches can post major barriers to successful nesting. The late August/September timeframe of most of the recent Gulf of Mexico storms was toward the end of the sea turtle nesting season (generally April/May to October). Many nests had successfully hatched prior to storm damage (Florida Fish and Wildlife Conservation Commission, 2008).

In response to a request by the Gulf of Mexico Fishery Management Council, NMFS issued an emergency closure for the bottom longline fishery in the eastern Gulf from May 18 through October 28, 2009 (74 FR 83). The affected fishery operates primarily off the west Florida shelf, which is an important sea turtle foraging habitat. A decline in the number of reproducing female loggerheads has been suggested as one of the reasons for recent declines in the annual loggerhead sea turtle nest counts in peninsular Florida. The bottom longline fishery takes sea turtles, including adult females, incidentally as bycatch. Further restrictions and/or mitigations may be required after the expiration of this closure. Although the area of greatest impact from this commercial fishing activity is not in the CPA, such impact to the loggerhead sea turtle population must be considered with cumulative impacts. Concern over declining numbers of loggerhead sea turtles is reflected in NMFS's second revision of the Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), which replaced the previous 1991 report (USDOC, NMFS and USDOI, FWS, 2008).

One of the major threats to marine turtles in the marine environment is incidental capture, injury, and mortality during fishing operations. To address interactions between marine turtles and trawl fishing gear, NMFS worked cooperatively with the commercial shrimp trawl industry to develop turtle excluder devices.

Leatherback Sea Turtle

The leatherback is the most abundant sea turtle in waters over the northern Gulf of Mexico continental slope (Mullin and Hoggard, 2000). The leatherback sea turtle is listed as endangered. Leatherbacks appear to spatially use both continental shelf and slope habitats in the Gulf of Mexico (Fritts et al., 1983b; Collard, 1990; Davis and Fargion, 1996). Surveys suggest that the region from Mississippi Canyon to De Soto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Mullin and Hoggard, 2000). Leatherbacks have been frequently sighted in the Gulf of Mexico during both summer and winter (Mullin and Hoggard, 2000).

On the Atlantic side of Florida, an increase in leatherback nesting numbers from 98 nests in 1988 to 800-900 nests per season in the early 2000's has been recorded. There has been a substantial increase in leatherback nesting in Florida since 1989 (USDOC, NMFS and USDOI, FWS, 2007a). Florida received a near record number of leatherback nests on beaches in 2010 (Florida Fish and Wildlife Conservation Commission, 2010b). Although nesting is very rare on Gulf of Mexico beaches, leatherbacks occur in Gulf of Mexico waters. Satellite telemetry and tag returns have shown that some of the leatherbacks present in the Gulf of Mexico were tagged at nesting beaches in Costa Rica and Panama (USDOC, NMFS and USDOI, FWS, 2007a).

Critical habitat for the leatherback sea turtle includes the waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands. There is no critical habitat designation for the leatherback sea turtle in the GOM. Ongoing threats to leatherbacks include ingestion of marine debris, poaching of eggs and animals, and entanglement in longline fishing gear.

Species/Critical Habitat Description

The leatherback sea turtle was listed as endangered on June 2, 1970 (35 FR 8491). Leatherback distribution and nesting grounds are found circumglobally and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, and the GOM (Ernst et al., 1994). Adult leatherbacks forage in temperate and subpolar regions from 71° N. to 47° S. latitude in all oceans and undergo extensive migrations between 90° N. and 20° S. latitude to and from the tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (USDOC, NMFS, 2001). Female leatherbacks nest from the southeastern U.S. to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic. The most significant nesting beaches in the Atlantic, and perhaps in the world, are in French Guiana and Suriname (USDOC, NMFS, 2001).

The leatherback is the largest and most pelagic of sea turtles. The average curved carapace length for adults is 155 cm (61 in) and weights from worldwide populations range from 200 to 700 kg (441 to 1,543 lb). Adults may attain weights up to and exceeding 1,000 kg (2,205 lb) and reach lengths of 1.9 m (6.2 ft). The leatherback forages widely throughout the water column from the surface to great depths throughout tropical and temperate oceans of the world. An adult leatherback was reported, by extrapolation of data, to achieve a maximum dive of 1,300 m (4,265 ft) (Eckert et al., 1989). The distribution of leatherbacks appears to be dependent upon the distribution of their gelatinous prey (Leary, 1957), consisting mostly of scyphomedusae (jellyfish) and pelagic tunicates. Leatherbacks typically lay a clutch of approximately 100 eggs within a nest cavity, requiring approximately 60 days of incubation until pipping. Hatchlings average 61.3 mm (2.4 in) long and 44.4 g (9.8 lb) in mass. Neonate leatherbacks are the most active sea turtle species, crawling immediately across the beach to the sea upon emergence and swimming both day and night for at least 6 days after entering the surf (Wyneken and Salmon, 1992).

Life History

The leatherback is the largest living turtle and it ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (USDOC, NMFS and USDOI, FWS, 1992). Adult leatherbacks forage in temperate and subpolar regions from 71° N. to 47° S. latitude in all oceans and undergo extensive migrations to and from tropical nesting beaches between 90° N. and 20° S. latitude. Female leatherbacks nest from the southeastern U.S. to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic, with nesting occurring as early as late February or March. When they leave the nesting beaches, leatherbacks move offshore but eventually utilize both coastal and pelagic waters. Very little is known about the pelagic habits of the hatchlings and juveniles, and they have not been documented to be associated with the *Sargassum* areas as are other species. Leatherbacks are deep divers, with estimated dives to depths in excess of 1,000 m (3,281 ft) (Eckert et al., 1989), but they may come into shallow waters if there is an abundance of jellyfish nearshore.

Although leatherbacks are a long-lived species (>30 years), they are somewhat faster to mature than loggerheads, with an estimated age at sexual maturity reported of about 13-14 years for females and an estimated minimum age at sexual maturity of 3-6 years, with 9 years reported as a likely minimum and 19 years as a likely maximum (Zug and Parham, 1996). They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years. During each nesting, females produce 100 eggs or more in each clutch and, thus, can produce 700 eggs or more per nesting season (Schultz, 1975).

Leatherback sea turtles feed primarily on jellyfish as well as cnidarians and tunicates. They are also the most pelagic of the turtles, but they have been known to enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated.

Population Dynamics

Leatherbacks are widely distributed throughout the oceans of the world and are found in waters of the Atlantic, Pacific, Caribbean, and the GOM (Ernst and Barbour, 1972). A population estimate of greater than or equal to 34,500 females (26,200-42,900) was made by Spotila et al. (1996), along with a claim that the species as a whole was declining and local populations were in danger of extinction (USDOC, NMFS, 2001). Genetic analyses of leatherbacks to date indicate that within the Atlantic basin significant genetic differences occur between St. Croix (U.S. Virgin Islands) and mainland Caribbean populations (Florida, Costa Rica, Suriname/French Guiana) and between Trinidad and the mainland Caribbean populations (Dutton et al., 1999), leading to the conclusion that there are at least three separate subpopulations of leatherbacks in the Atlantic. The primary leatherback nesting beaches occur in French Guiana, Suriname, and Costa Rica in the western Atlantic, and in Mexico in the eastern Pacific. Recent declines have been seen in the number of leatherbacks nesting worldwide (USDOC, NMFS and USDOI, FWS, 1992). Adult mortality has increased significantly from interactions with fishery gear (Spotila et al., 1996). The Pacific population is in a critical state of decline, now estimated to number less than 3,000 total adult and subadult animals (Spotila et al., 2000). The status of the Atlantic population is less clear. In 1996, it was reported to be stable, at best (Spotila et al., 1996), but numbers in the western

Atlantic at that time were reported to be on the order of 18,800 nesting females. The western Atlantic population currently numbers about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the eastern Atlantic, off Africa (numbering 4,700) have remained consistent with numbers reported by Spotila et al. (1996).

The nesting aggregation in French Guiana has been declining annually at about 15 percent since 1987. From 1979 to 1986, the number of nests was increasing at about 15 percent annually. The number of nests in Florida and the U.S. Caribbean has been increasing at about 10.3 and 7.5 percent, respectively, per year since the early 1980's, but the magnitude of nesting is much smaller than that along the French Guiana coast (USDOC, NMFS, 2001). In summary, the conflicting information regarding the status of Atlantic leatherbacks makes it difficult to conclude whether or not the population is currently in decline, numbers at some nesting sites are up, while at others they are down.

Status and Distribution

Leatherback sea turtles are susceptible to ingestion of marine debris (Balazs, 1985; Fritts, 1982; Lutcavage et al., 1997; Mrosovsky, 1981; Shoop and Kenney, 1992). Poaching of eggs and animals still occurs. In the U.S. Virgin Islands, four of five strandings in St. Croix were the result of poaching (Boulon, 2000).

Leatherbacks may become entangled in longline gear (USDOC, NMFS, 2001, Part III, Chapter 7), buoy lines, lobster pot lines (Prescott, 1988), and trawl fisheries (Marcano and Alio-M, 2000). During the period 1977-1987, 89 percent of the 57 stranded adult leatherbacks were the result of entanglement (Prescott, 1988), and during the period 1990-1996, 58 percent of the 59 stranded adult leatherbacks showed signs of entanglement. Leatherback sea turtles also are vulnerable to capture in gillnets (Goff et al., 1994; Castroviejo et al., 1994; Chevalier et al., 1999; Lagueux, 1998; Eckert and Lien, 1999).

Of the Atlantic turtle species, leatherback turtles seem to be the most susceptible to entanglement. This susceptibility may be the result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the lightsticks used to attract target species in the longline fishery. The observed take of leatherbacks by the Atlantic pelagic longline fishery during 1992 through 1999 was 263 turtles. When extrapolated for the entire Atlantic fishery, the estimated number of leatherbacks caught on longlines was 6,363 turtles. Most of the caught turtles were expected to be alive and released. Of the 6,363 estimated turtles caught, 88 (1.4%) were expected to be dead (USDOC, NMFS, 2001).

According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992 and 1999, of which 88 were discarded dead (USDOC, NMFS, 2001). However, the U.S. fleet accounts for a small portion (5-8%) of the hooks fished in the Atlantic Ocean compared with other nations, including Taipei, Brazil, Trinidad, Morocco, Cyprus, Venezuela, Korea, Mexico, Cuba, United Kingdom, Bermuda, People's Republic of China, Grenada, Canada, Belize, France, and Ireland (Carocci and Majkowski, 1998). Reports of incidental takes of turtles are incomplete for many of these nations (USDOC, NMFS, 2001; see Part II, Chapter 5, page 162 for a complete description of take records). Adding up the underrepresented observed takes per country per year of 23 actively fishing countries would likely result in estimates of thousands of sea turtles taken annually over different life stages.

Green Sea Turtle

All green sea turtle populations are listed as threatened except for the breeding populations of Florida and the Pacific Coast of Mexico, which are endangered. Green sea turtles are found throughout the GOM and are known to nest on GOM beaches, but in very small numbers (USDOC, NMFS and USDOI, FWS, 2007b). Reports of green turtles nesting along the Gulf Coast are infrequent.

The east coast of Florida is one of the most important nesting areas for green turtles. Between 1989 and 2010, the annual number of green sea turtle nests ranged from 267 to 9,091. Green turtle nests have increased by a factor of 10 over the last 22 years (Florida Fish and Wildlife Conservation Commission, 2010b).

After emerging from the nest, hatchlings swim to offshore areas, where they are believed to live for several years, feeding close to the surface on a variety of pelagic plants and animals. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds.

Once they move to these nearshore benthic habitats, adult green turtles are almost exclusively herbivores, feeding on seagrasses and algae. Adult females migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of kilometers each way (USDOC, NMFS and USDOI, FWS, 2007b).

The principal cause of past declines and extirpations of green turtle assemblages has been the over-exploitation of green turtles for eggs and meat. Significant threats on green turtle nesting beaches in the region include beach armoring, erosion control, artificial lighting, and disturbance. Armoring of beaches (e.g., seawalls, revetments, rip-rap, sandbags, and sand fences) in Florida, which is meant to protect developed property, is increasing and has been shown to discourage nesting, even when armoring structures do not completely block access to nesting habitat (Mosier, 1998).

Species/Critical Habitat Description

Federal listing of the green sea turtle occurred on July 28, 1978 (43 FR 32808), with all populations listed as threatened except for the breeding populations of Florida and Pacific coast of Mexico, which are endangered. The complete nesting range of the green turtle within NMFS's, Southeast Region includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina and at the U.S. Virgin Islands and Puerto Rico (USDOC, NMFS and USDOI, FWS, 1991a). Principal U.S. nesting areas for green turtles are in eastern Florida, predominantly Brevard through Broward Counties (Ehrhart and Witherington, 1992). Regular green turtle nesting also occurs on St Croix, U.S. Virgin Islands, and on Vieques, Culebra, Mona, and the main island of Puerto Rico (Mackay and Rebholz, 1996).

Critical habitat for the green sea turtle has been designated for the waters surrounding Isla Culebra, Puerto Rico, and its associated keys.

Life History

Green sea turtle mating occurs in the waters off the nesting beaches. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12- to 14-day intervals. Mean clutch size is highly variable among populations but averages 110-115. Females usually have 2-4 or more years between breeding seasons, while males may mate every year (Balazs, 1983). After hatching, green sea turtles go through a post-hatchling pelagic stage where they are associated with drift lines of algae and other debris.

Green turtle foraging areas in the southeast U.S. include any neritic waters having macroalgae or seagrasses near mainland coastlines, islands, reefs, or shelves, and any open-ocean surface waters, especially where advection from wind and currents concentrates pelagic organisms (Hirth, 1997; USDOC, NMFS and USDOI, FWS, 1991a). Principal benthic foraging areas in the region include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty, 1984; Hildebrand, 1982; Shaver, 1994a and 1994b), the GOM off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr, 1957; Carr, 1984), Florida Bay and the Florida Keys (Schroeder and Foley, 1995), the Indian River Lagoon System, Florida (Ehrhart, 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Wershoven and Wershoven, 1992; Guseman and Ehrhart, 1992). Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs. Age at sexual maturity is estimated to be between 20 and 50 years (Balazs, 1982; Frazer and Ehrhart, 1985).

Green sea turtles are primarily herbivorous, feeding on algae and seagrasses, but they also occasionally consume jellyfish and sponges. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available.

Population Dynamics

The vast majority of green turtle nesting within the southeast U.S. occurs in Florida. In Florida from 1989 to 1999, green turtle abundance from nest counts ranged between 109 and 1,389 nesting females per year (Meylan et al., 1995); estimates assume 4 nests per female per year (Johnson and Ehrhart, 1994). High biennial variation and a predominant 2-year remigration interval (Witherington and Ehrhart, 1989; Johnson and Ehrhart, 1994) warrant combining even and odd years into 2-year cohorts. This gives an estimate of total nesting females that ranged between 705 and 1,509 during the period 1990-1999. It is important to note that, because methodological limitations make the clutch frequency number (4 nests/ female/year) an underestimate (by as great as 50%), a more conservative estimate is 470-1,509 nesting females in Florida between 1990 and 1999. In Florida during the period 1989-1999, the numbers of green turtle nests by year show no trend. However, odd-even year cohorts of nests do show a significant increase during the period 1990-1999.

It is unclear how greatly green turtle nesting in the whole of Florida has been reduced from historical levels, although one account indicates that nesting in Florida's Dry Tortugas may now be only a small fraction of what it once was (Audubon, 1926; Dodd, 1981). Total nest counts and trends at index beach sites during the past decade suggest that green turtles that nest within the southeast U.S. are recovering and have only recently reached a level of approximately 1,000 nesting females. There are no reliable estimates of the number of green turtles inhabiting foraging areas within the southeast U.S., and it is likely that green turtles foraging in the region come from multiple genetic stocks. These trends are also uncertain because of a lack of data. However, there is one sampling area in the region with a large time series of constant turtle-capture effort that may represent trends for a limited area within the region. This sampling area is at an intake canal for a power plant on the Atlantic coast of Florida where 2,578 green turtles have been captured during the period 1977-1999 (Florida Power and Light, 2000). At the power plant, the annual number of immature green turtle captures (minimum straight-line carapace length <85 cm (33 in) has increased significantly during the 23-year period.

The status of immature green turtles foraging in the southeast U.S. might also be assessed from trends at nesting beaches where many of the turtles originated, principally, Florida, Yucatán, and Tortuguero. Trends at Florida beaches are presented above. Trends in nesting at Yucatán beaches cannot be assessed because of irregularity in beach survey methods over time. Trends at Tortuguero (20,000-50,000 nests/ year) show a significant increase in nesting during the period 1971-1996 (Bjorndal et al., 1999).

Status and Distribution

The principal cause of past declines and extirpations of green turtle assemblages has been the over-exploitation of green turtles for food and other products. Adult and immature green turtles are still exploited heavily on foraging grounds off Nicaragua and to a lesser extent off Colombia, Mexico, Panama, Venezuela, and the Tortuguero nesting beach (Carr et al., 1978; Nietschmann, 1982; Bass et al., 1998; Lagueux, 1998).

Significant threats on green turtle nesting beaches in the region include beach armoring, erosion control, artificial lighting, and disturbance. Armoring of beaches (e.g., seawalls, revetments, rip-rap, sandbags, and sand fences) in Florida, which is meant to protect developed property, is increasing and has been shown to discourage nesting even when armoring structures do not completely block access to nesting habitat (Mosier, 1998). Hatchling sea turtles on land and in the water that are attracted to artificial light sources may suffer increased predation proportional to the increased time spent on the beach and in the predator-rich nearshore zone (Witherington and Martin, 2000).

Green turtles depend on shallow foraging grounds with sufficient benthic vegetation. Direct destruction of foraging areas because of dredging, boat anchorage, deposition of spoil, and siltation (Coston-Clements and Hoss, 1983; Williams, 1988) may have considerable effects on the distribution of foraging green turtles. Eutrophication, heavy metals, radioactive elements, and hydrocarbons all may reduce the extent, quality, and productivity of foraging grounds (Frazier, 1980).

Pollution also threatens the pelagic habitat of juvenile green turtles. Older juvenile green turtles have also been found dead after ingesting seaborne plastics (Balazs, 1985). A major threat from manmade debris is the entanglement of turtles in discarded monofilament fishing line and abandoned netting (Balazs, 1985).

The occurrence of green turtle fibropapillomatosis disease was originally reported in the 1930’s, when it was thought to be rare (Smith and Coates, 1938). At present, this disease is cosmopolitan and has been found to affect large numbers of animals in some areas, including Hawaii and Florida (Herbst, 1994; Jacobson, 1990; Jacobson et al., 1991). The tumors are commonly found in the eyes, occluding sight; the turtles are often discovered entangled in debris and are frequently infected secondarily.

Predation on sea turtles by animals other than humans occurs principally during the egg and hatchling stage of development (Stancyk, 1982). Mortality, because of predation of early stages, appears to be relatively high naturally, and the reproductive strategy of the animal is structured to compensate for this loss (Bjorndal, 1980).

Green turtles are often captured and drowned in nets set to catch fishes. Gillnets, trawl nets, pound nets (Crouse, 1982; Hillestad et al., 1982; NRC, 1990), and abandoned nets of many types (Balazs, 1985; Ehrhart et al., 1990) are known to catch and kill sea turtles. To address interactions between marine turtles and trawl fishing gear, NMFS worked cooperatively with the commercial shrimp trawl industry to develop turtle excluder devices. Green turtles also are taken by hook and line fishing. Collisions with power boats and encounters with suction dredges have killed green turtles along the U.S. coast and may be common elsewhere where boating and dredging activities are frequent.

Hawksbill Sea Turtle

Hawksbill sea turtles were once abundant in tropical and subtropical regions. Pelagic-size individuals and small juveniles are not uncommon and are believed to be animals dispersing from nesting beaches in the Yucatán Peninsula of Mexico and farther south in the Caribbean (Amos, 1989). The hawksbill turtle is listed as endangered and is considered critically endangered by the International Union for the Conservation of Nature based on global population declines of over 80 percent during the last three generations (105 years) (Meylan and Donnelly, 1999). The Atlantic Coast of Florida is the only area in the U.S. where hawksbills nest on a regular basis.

Hawksbill sea turtles are highly migratory and use a wide range of habitats during their lifetime. As with most sea turtle species, hatchlings and early juveniles are often found in association with oceanic *Sargassum* floats. As later juveniles, they move nearshore for feeding habitat and may associate with the same feeding locality for more than a decade (Musick and Limpus, 1997). In the continental U.S., hawksbills are found primarily in Florida and Texas, although they have been recorded in all the GOM States and along the east coast as far north as Massachusetts. The Atlantic Coast of Florida is the only area in the U.S. where hawksbills nest on a regular basis.

Hawksbills are threatened by all the factors that threaten other marine turtles, including exploitation for meat, eggs, and the curio trade; loss or degradation of nesting and foraging habitats; increased human presence; nest depredation; oil pollution; incidental capture in fishing gear; ingestion of and entanglement in marine debris; and boat collisions (Lutcavage et al., 1997; Meylan and Ehrenfeld, 2000). The primary cause of hawksbill decline has been attributed to centuries of exploitation for tortoiseshell, the beautifully patterned scales that cover the turtle’s shell (Parsons, 1972). Another manmade factor that affects hawksbills in foraging areas and on nesting beaches is global climate change (USDOC, NMFS and USDOI, FWS, 2007c).

Species/Critical Habitat Description

Long-term trends in hawksbill nesting in Florida are unknown, although there are a few historical reports of nesting in south Florida and the Keys (True, 1884; Audubon, 1926; DeSola, 1935). No nesting trends were evident in Florida from 1979 to 2000; between 0 and 4 nests are recorded annually. The hawksbill has been recorded in all of the Gulf Coast States. Nesting on Gulf beaches is extremely rare and one nest was documented at Padre Island in 1998 (Mays and Shaver, 1998). Pelagic-size individuals and small juveniles are not uncommon and are believed to be animals dispersing from nesting beaches in the Yucatán Peninsula of Mexico and farther south in the Caribbean (Amos, 1989). The majority of hawksbill sightings are reported from the sea turtle stranding network. Strandings from 1972 to 1989 were concentrated at Port Aransas, Mustang Island, and near the headquarters of the Padre Island National Seashore, Texas (Amos, 1989). Live hawksbills are sometimes seen along the jetties at Aransas Pass Inlet. Other live sightings include a 24.7-cm (9.7-in) juvenile captured in a net at Mansfield Channel in May 1991 (Shaver, 1994b) and periodic sightings of immature animals in the Flower Gardens National Marine Sanctuary.

The hawksbill turtle was listed as endangered on June 2, 1970, and is considered critically endangered by the International Union for the Conservation of Nature (IUCN) based on global population declines of over 80 percent during the last three generations (105 years) (Meylan and Donnelly, 1999). In the western Atlantic, the largest hawksbill nesting population occurs in the Yucatán Peninsula of Mexico (Garduño-Andrade et al., 1999) with other important but significantly smaller nesting aggregations found in Puerto Rico, the U.S. Virgin Islands, Antigua, Barbados, Costa Rica, Cuba, and Jamaica (Meylan, 1999a). The species occurs in all ocean basins, although it is relatively rare in the eastern Atlantic and eastern Pacific, and absent from the Mediterranean Sea. Hawksbills have been observed on the coral reefs south of Florida, but they are also found in other habitats including inlets, bays, and coastal lagoons. A surprisingly large number of small hawksbills have also been encountered in Texas. The diet is highly specialized and consists primarily of sponges (Meylan, 1988), although other food items have been documented to be important in some areas of the Caribbean (van Dam and Diez, 1997; Mayor et al.; 1998; Leon and Diez, 2000). The lack of sponge-covered reefs and the cold winters in the northern Gulf likely prevent hawksbills from establishing a strong population in this area.

Critical habitat for the hawksbill turtle includes Mona and Monito Islands, Puerto Rico, and the waters surrounding these islands, out to 3 nmi (3.5 mi; 5.6 km). Mona Island receives protection as a Natural Reserve under the administration of the Puerto Rico Department of Natural Resources and Environment. The coral reef habitat and cliffs around Mona Island and nearby Monito Island are an important feeding ground for all sizes of post-pelagic hawksbills. Genetic research has shown that this feeding population is not primarily composed of hawksbills that nest on Mona, but instead includes animals from at least six different nesting aggregations, particularly the U.S. Virgin Islands and the Yucatán Peninsula (Mexico) (Bowen et al., 1996; Bass, 1999). Genetic data indicate that some hawksbills hatched at Mona use feeding grounds in waters of other countries, including Cuba and Mexico. Hawksbills in Mona waters appear to have limited home ranges and may be resident for several years (van Dam and Diez, 1998).

Life History

The life history of hawksbills consists of a pelagic stage that lasts from the time they leave the nesting beach as hatchlings until they are approximately 22-25 cm (9-10 in) in straight carapace length (Meylan, 1988), followed by residency in developmental habitats (foraging areas where immature individuals reside and grow) in coastal waters. Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hard-bottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over periods of time as great as several years (van Dam and Diez, 1998).

Hawksbills may undertake developmental migrations (migrations as immature turtles) and reproductive migrations that involve travel over hundreds or thousands of kilometers (Meylan, 1999b). Reproductive females undertake periodic (usually nonannual) migrations to their natal beach to nest. Movements of reproductive males are less well known, but they are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor. Females nest an average of 3-5 times per season, and the clutch size is up to 250 eggs (Hirth, 1980). Reproductive females may exhibit a high degree of nesting fidelity to their natal beaches.

Population Dynamics

Mona Island (Puerto Rico, 18º05' N. latitude, 67º57' W. longitude) has 7.2 km (4.5 mi) of sandy beach that host the largest known hawksbill nesting aggregation in the Caribbean Basin, with over 500 nests recorded annually from 1998 to 2000. The island has been surveyed for marine turtle nesting activity for more than 20 years; surveys since 1994 show an increasing trend. Increases are attributed to nest protection efforts in Mona and fishing reduction in the Caribbean. The U.S. Virgin Islands are also an important hawksbill nesting location. Buck Island Reef National Monument off St. Croix has been surveyed for nesting activity since 1987, where between 1987 and 1999, between 73 and 135 hawksbill nests had been recorded annually (Meylan and Donnelly, 1999). This population, although small, is considered to be stable. Nesting beaches on Buck Island experience large-scale beach erosion and accretion as a result of hurricanes, and nests may be lost to erosion or burial. Predation of nests by mongoose is a serious problem and requires intensive trapping. Hawksbill nesting also occurs elsewhere on St. Croix, St. John, and St. Thomas. Juvenile and adult hawksbills are common in the waters of the U.S. Virgin Islands. Immature hawksbills tagged at St. Thomas during long-term, in-water studies appeared to be resident for extended periods (Boulon, 1994). Tag returns were recorded from St. Lucia, the British Virgin Islands, Puerto Rico, St. Martin, and the Dominican Republic (Boulon, 1989; Meylan, 1999b).

The Atlantic Coast of Florida is the only area in the U.S. where hawksbills nest on a regular basis, but four is the maximum number of nests documented in any year during 1979-2000. Nesting occurs as far north as Volusia County, Florida, and south to the Florida Keys, including Boca Grande and the

Marquesas. Soldier Key in Miami-Dade County has had more nests than any other location, and it is one of the few places in Florida mentioned in the historical literature as having been a nesting site for hawksbills (DeSola, 1935). There is also a report of a nest in the late 1970's at nearby Cape Florida. It is likely that some hawksbill nesting in Florida goes undocumented because of the great similarity of the tracks of hawksbills and loggerheads. All documented records of hawksbill nesting from 1979 to 2000 took place between May and December except for one April nest in the Marquesas.

Twenty-four hawksbills were removed from the intake canal at the Florida Power and Light St. Lucie Plant in Juno Beach (St. Lucie County) during 1978-2000 (Florida Power and Light, 2000). The animals ranged in size from 34.0- to 83.4-cm (13.4- to 32.8-in) straight carapace length and were captured in most months of the year. Immature hawksbills have been recorded on rare occasions in both the Indian River Lagoon (Indian River County) and Mosquito Lagoon (Brevard County). A 24.8-cm (9.8-in) hawksbill was captured on the worm reefs 200 m (656 ft) off the coast in Indian River County.

Records of hawksbills north of Florida are relatively rare, although several occurrences have been documented (Parker, 1996; Ruckdeschel et al., 2000; Epperly, 1996; Schwartz, 1976; Keinath and Musick, 1991).

Status and Distribution

Hawksbills are threatened by all the factors that threaten other marine turtles, including exploitation for meat, eggs, and the curio trade, loss or degradation of nesting and foraging habitats, increased human presence, nest depredation, oil pollution, incidental capture in fishing gear, ingestion of and entanglement in marine debris, and boat collisions (Lutcavage et al., 1997; Meylan and Ehrenfeld, 2000). The primary cause of hawksbill decline has been attributed to centuries of exploitation for tortoiseshell, the beautifully patterned scales that cover the turtle's shell (Parsons, 1972). International trade in tortoiseshell is now prohibited among all signatories of the Convention on International Trade in Endangered Species; however, some illegal trade continues, as does trade between nonsignatories.

Kemp's Ridley Sea Turtle

The nearshore waters of the GOM are believed to provide important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles. Ogren (1989) suggests that the Gulf Coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern GOM. Internationally, the Kemp's ridley is considered the most endangered sea turtle. There is no designated critical habitat for the Kemp's ridley sea turtle; however, on February 17, 2010, NMFS and FWS were jointly petitioned to designate critical habitat for Kemp's ridley sea turtles for nesting beaches and for marine habitats in the GOM and Atlantic Ocean. The NMFS is currently reviewing the petition.

The species occurs mainly in coastal areas of the GOM and the northwestern Atlantic Ocean. Kemp's ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico, Tamaulipas State. A 2007 arribada at Rancho Nuevo included over 4,000 turtles over a 3-day period (USDOC, NMFS and USDOI, FWS, 2007d). Kemp's ridley sea turtle nest numbers reported along the 47-mi (76-km) stretch of Alabama coastline were 1 nest in 2006, 2007, and 2008. Louisiana and Mississippi have few, if any, nests. Kemp's ridley sea turtle nests have increased in recent years along South Padre Island National Seashore in Texas.

Of the seven extant species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Many threats to the future of the species remain, including interactions with fishery gear, marine pollution, foraging habitat destruction, illegal poaching of nests, and the potential threats to nesting beaches from such sources as global climate change, development, and tourism pressures (USDOC, NOAA, 2011a).

Species/Critical Habitat Description

The Kemp's ridley was listed as endangered on December 2, 1970. Internationally, the Kemp's ridley is considered the most endangered sea turtle. Kemp's ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico, Tamaulipas State. The species occurs mainly in coastal areas of the GOM and the northwestern Atlantic Ocean. Occasional individuals reach European waters. Adults of this species are usually confined to the GOM, although adult-sized individuals sometimes are found on the Eastern Seaboard of the U.S.

Life History

Remigration of females to the nesting beach varies from annually to every 4 years, with a mean of 2 years (Turtle Expert Working Group, 1998). Nesting occurs from April into July and is essentially limited to the beaches of the western GOM, near Rancho Nuevo in southern Tamaulipas, Mexico. The mean clutch size for Kemp's ridleys is 100 eggs/nest, with an average of 2.5 nests/female/season.

Juvenile/subadult Kemp's ridleys have been found along the Eastern Seaboard of the U.S. and in the GOM. Atlantic juveniles/subadults travel northward with vernal warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the cold (Lutcavage and Musick, 1985; Henwood and Ogren, 1987; Ogren, 1989). In the GOM, juvenile/ subadult ridleys occupy shallow, coastal regions. Ogren (1989) suggested that in the northern Gulf they move offshore to deeper, warmer water during winter. Studies suggest that subadult Kemp’s ridleys stay in shallow, warm, nearshore waters in the northern GOM until cooling waters force them offshore or south along the Florida coast (Renaud, 1995). Little is known of the movements of the post-hatching, planktonic stage within the Gulf. Studies have shown the post-hatchling pelagic stage varies from 1 to 4 or more years, and the benthic immature stage lasts 7-9 years (Schmid and Witzell, 1997). The Turtle Expert Working Group (1998) estimates age at maturity to range from 7 to 15 years.

Stomach contents of Kemp’s ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be shrimp fishery discards (Shaver, 1991). Pelagic stage, neonatal Kemp’s ridleys presumably feed on the available *Sargassum* and associated infauna or other epipelagic species found in the GOM.

Population Dynamics

Kemp’s ridleys have a very restricted distribution relative to other sea turtle species. Data suggest that adult Kemp’s ridley turtles are restricted somewhat to the GOM in shallow nearshore waters. Benthic immature turtles with a 20- to 60-cm (8- to 24-in) straight-line carapace length are found in nearshore coastal waters including estuaries of the GOM and the Atlantic, although adult-sized individuals sometimes are found on the Eastern Seaboard of the U.S. The post-pelagic stages are commonly found dwelling over crab-rich sandy or muddy bottoms. Juveniles frequent bays, coastal lagoons, and river mouths.

Of the seven extant species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the Rancho Nuevo beaches (Pritchard, 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand, 1963). By the early 1970’s, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980’s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and the population is now increasing. Nesting at Tamaulipas and Veracruz increased from a low of 702 nests in 1985 to 1,930 nests in 1995 and to 6,277 nests in 2000. The population model used by the Turtle Expert Working Group (1998) projected that Kemp’s ridleys could reach the Recovery Plan’s intermediate recovery goal of 10,000 nesters by 2020 if the assumptions of age to sexual maturity and age-specific survivorship rates used in their model are correct.

Status and Distribution

The largest contributor to the decline of the ridley in the past was commercial and local exploitation, especially poaching of nests at the Rancho Nuevo site, as well as the GOM trawl fisheries. The advent of the turtle excluder device regulations for trawlers and protections for the nesting beaches have allowed the species to begin to rebound. Many threats to the future of the species remain, including interactions with fishery gear, marine pollution, foraging habitat destruction, illegal poaching of nests, and the potential threats to nesting beaches from such sources as global climate change, development, and tourism pressures.

Loggerhead Sea Turtle

Loggerhead sea turtles are considered a threatened species. In the GOM, loggerheads nest primarily in southwest Florida with minimal nesting outside of this range westward to Texas. Loggerhead turtles have been primarily sighted in waters over the continental shelf, although many surface sightings of this species have also been made over the outer slope beyond the 1,000-m (3,281-ft) isobath. Hatchlings emerge from the nest and swim away from land for several days. Offshore, they reside for months in the oceanic zone in *Sargassum* floats, generally along the Loop Current and the Gulf Coast of Florida. Somewhere between 7 and 12 years old, oceanic juveniles migrate to nearshore coastal areas to mature into adults. These nearshore waters become important foraging and migratory habitat for juveniles and adults. Juveniles may also spend time in bays, sounds, and estuaries. Adult loggerheads are known to make extensive migrations between foraging areas and nesting beaches. During nonnesting years, adult females from U.S. beaches are distributed in waters off the eastern U.S. and throughout the GOM, Bahamas, Greater Antilles, and Yucatán (Conant et al., 2009).

Ongoing threats to the western Atlantic loggerhead populations include incidental takes from dredging, commercial trawling, longline fisheries, and gillnet fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; nest predation by native and nonnative predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease (USDOC, NOAA, 2011a).

In the past decade, a 39.5 percent decline in the annual number of nests has been reported (USDOC, NMFS and USDOI, FWS, 2007e). The Florida Panhandle Nesting Subpopulation showed a decline of 6.6 percent annually from 1995 to 2005. Loggerhead sea turtle nest numbers in 2010 were above the average of the preceding 10-year period (Florida Fish and Wildlife Conservation Commission, 2010b). Along the 47-mi (76-km) stretch of Alabama coastline, 62 loggerhead nests were reported in 2003, 53 in 2004, 37 in 2005, 45 in 2006, 54 in 2007, and 78 in 2008. Louisiana and Mississippi have few if any nests.

The NMFS has issued a final rule to list nine distinct population segments of loggerhead sea turtles under the ESA (76 FR 58868, September 22, 2011). At this time, none of the distinct population segments are located in the Gulf of Mexico.

Species/Critical Habitat Description

The loggerhead sea turtle was listed as a threatened species on July 28, 1978 (43 FR 32800). This species inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans, and within the continental U.S., and it nests from Louisiana to Virginia. The major nesting areas include the coastal islands of Georgia, South Carolina, and North Carolina, and the Atlantic and Gulf Coasts of Florida, with the bulk of the nesting occurring on the Atlantic Coast of Florida. Developmental habitat for small juveniles is the pelagic waters of the North Atlantic and the Mediterranean Sea.

Life History

Loggerheads mate in late March through early June in the Southeastern U.S. Females emerge from the surf, excavate a nest cavity in the sand, and deposit a mean clutch size of 100-126 eggs. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests/nesting individual (Murphy and Hopkins, 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years but can vary from 1 to 7 years (Dodd, 1988). Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic gyre for as long as 7-12 years or more, but there is some variation in habitat use by individuals at all life stages. Turtles in this early life history stage are called pelagic immatures. Stranding records indicate that, when pelagic immature loggerheads reach a 40- to 60-cm (16- to 24-in) straight-line carapace length, they begin to recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immature loggerheads, the life stage following the pelagic immature stage, have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico. Large benthic immature loggerheads (70-91 cm; 28-36 in) represent a larger proportion of the strandings and in-water captures along the south and western coasts of Florida as compared with the rest of the coast. Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly et al., 1995; Keinath, 1993; Morreale and Standora, 1999; Shoop and Kenney, 1992) and to migrate northward in spring. Past literature gave an estimated age at maturity of 21-35 years (Frazer and Ehrhart, 1985; Frazer et al., 1994) and the benthic immature stage as lasting at least 10-25 years. However, in 2001 the NMFS Southeast Fisheries Science Center reviewed the literature and constructed growth curves from new data, estimating ages of maturity ranging from 20 to 38 years and benthic immature stage lengths from 14 to 32 years. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd, 1988). Subadult and adult loggerheads are primarily coastal and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

Population Dynamics

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerhead sea turtles concentrate their nesting in the north and south temperate zones and subtropics, but they generally do not nest in tropical areas of Central America, northern South America, and the Old World (Magnuson et al., 1990).

In the western Atlantic, most loggerhead sea turtles nest in the geographic area ranging from North Carolina to the Florida Panhandle. There are five western Atlantic subpopulations, divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29° N. latitude (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N. latitude on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez, 1990) (approximately 1,000 nests in 1998) (Turtle Expert Working Group, 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year) (USDOC, NMFS, 2001). Reproductive adult females return to their original hatching site to nest, providing a natural barrier between these five subpopulations.

Based on the available data, it is difficult to estimate the size of the loggerhead sea turtle population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989 to 1998 represent the best dataset available to index the population size of loggerhead sea turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females but may not reflect overall population growth rates. Given this caveat, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf Coasts ranged from 53,014 to 92,182 annually, with a mean of 73,751. On average, 90.7 percent of these nests were from the south Florida subpopulation, 8.5 percent were from the northern subpopulation, and 0.8 percent were from the Florida Panhandle nest sites. There is limited nesting throughout the GOM west of Florida, but it is not known to which subpopulation these nesting females belong.

The number of nests in the northern subpopulation from 1989 to 1998 was 4,370-7,887, with a 10-year mean of 6,247 nests. With each female producing an average of 4.1 nests in a nesting season, the average number of nesting females per year in the northern subpopulation was 1,524. The total nesting and nonnesting adult female population is estimated as 3,810 adult females in the northern subpopulation (Turtle Expert Working Group, 1998 and 2000). The northern subpopulation, based on number of nests, has been classified as stable or declining (Turtle Expert Working Group, 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate that the northern subpopulation produces 65 percent males, while the south Florida subpopulation is estimated to produce 80 percent females (USDOC, NMFS, 2001).

The southeastern U.S. nesting aggregation is of great importance on a global scale and is second in size only to the nesting aggregation on islands in the Arabian Sea off Oman (Ross, 1979; Ehrhart, 1989; USDOC, NMFS and USDOI, FWS, 1991b). The global importance of the southeast U.S. nesting aggregation of loggerheads is especially important because the status of the Oman colony has not been evaluated recently, but it is located in an area of the world where it is highly vulnerable to disruptive events such as political upheavals, wars, catastrophic oil spills, and lack of strong protections (Meylan et al., 1995).

Status and Distribution

Ongoing threats to the western Atlantic loggerhead populations include incidental takes from dredging, commercial trawling, longline fisheries, and gillnet fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; nest predation by native and nonnative predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease.

Loggerhead sea turtles face numerous threats from natural causes. The five known subpopulations of loggerhead sea turtles in the northwest Atlantic that nest in the southeastern U.S. are subject to fluctuations in the number of young produced annually because of natural phenomena, such as hurricanes, as well as human-related activities. There is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and the loggerhead sea turtle nesting season (March to November). Hurricanes can have potentially disastrous effects on the survival of eggs in sea turtle nests. In 1992, Hurricane Andrew affected turtle nests over a 90-mi (145-km) length of coastal Florida. All of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton et al., 1994). On Fisher Island near Miami, Florida, 69 percent of the eggs did not hatch after Hurricane Andrew, likely because of an inhibition of gas exchange between the eggshell and the submerged nest environment resulting from the storm surge. Nests from the northern subpopulation were destroyed by hurricanes that made landfall in North Carolina in the mid- to late 1990's. Sand accretion and rainfall that result from these storms can appreciably reduce hatchling success. Recent, very active hurricane seasons, and particularly the 2004, 2005 and 2008 (Hurricane Ike) seasons that caused massive damage all along the Gulf Coast, have no doubt continued to greatly stress sea turtle populations in the area. These natural phenomena probably have significant, adverse effects on the size of specific year classes, particularly given the increasing frequency and intensity of hurricanes in the Caribbean Sea and northwest Atlantic Ocean.

Deepwater Horizon Event

The DWH event and resulting oil spill in Mississippi Canyon Block 252 and the related spill-response activities (including use of dispersants) have impacted sea turtles that have come into contact with oil and remediation efforts. For the latest available information on oiled or affected sea turtles documented in the area, see NMFS's "Sea Turtles and the Gulf of Mexico Oil Spill" website (USDOC, NMFS, 2011b).

According to this NMFS website, 1,146 sea turtles have been collected (537 alive, 609 deceased) as of February 15, 2011). Of these, 201 were greens, 16 Hawksbills, 809 Kemp's ridleys, 88 loggerheads, and the remaining 32 unknown (USDOC, NMFS, 2011b). Individuals were documented either through strandings or directed offshore captures. Due to low detection rates of carcasses in prior events, it is possible that the number of deaths of sea turtles is underestimated (Epperly et al., 1996). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that not all carcasses were related to the DWH event oil spill. Over the last 2 years, NOAA has documented increased numbers of sea turtle strandings in the northern GOM. Many of the stranded turtles were reported from Mississippi and Alabama waters, and very few showed signs of external oiling (believed to be related to the DWH event). Necropsy results from many of the stranded turtles indicate mortality due to forced submergence, which is commonly associated with fishery interactions. In June 2011, NMFS announced that it will begin scoping for the preparation of a draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (76 FR 37050).

As a preventative measure during the DWH response effort, NMFS and FWS translocated a number of sea turtle nests and eggs that were located on beaches affected or potentially affected by spilled oil. According to the latest information on the NMFS stranding network website (USDOC, NMFS, 2011b), a total of 274 nests were translocated from GOM beaches to the east coast of Florida. These nests were mainly for hatchlings that would enter waters off Alabama and Florida's northwest Gulf Coast. Of these, 4 were from green turtles, 5 from Kemp's ridley and 265 from loggerheads, as indicated in the table below. The translocation effort ended August 19, 2010, at the time when biologists determined that risks to hatchlings emerging from beaches and entering waters off Alabama and Florida's northwest Gulf Coast had diminished significantly and that the risks of translocating nests during late incubation to the east coast of Florida outweighed the risks of letting hatchlings emerge into the Gulf of Mexico. The hatchlings resulting from the translocations were all released as of September 9, 2010.

Final data on nesting translocation, updated on April 19, 2011, is shown in the table below (USDOC, NMFS, 2011b):

Species	Translocated Nests	Hatchlings Released
Green turtle (*Chelonia mydas*)	4	455
Kemp's ridley turtle (*Lepidochelys kempii*)	5	125
Loggerhead turtle (*Caretta caretta*)	265*	14,216

*Does not include one nest that included a single hatchling and no eggs.
Note: All data is preliminary.

Source: USDOC, NMFS, 2011b.

As of August 3, 2010, in open water, there was no evidence that sea turtles were still being exposed to chemicals from the DWH event (OSAT, 2010). This report states, "Since 3 August [2010], no exceedances of the aquatic life benchmark for PAH's in water that were consistent with MC252 oil." It is likely that there were effects on individual sea turtles in the vicinity of the DWH event spill caused by spilled oil and/or response activities. Depending upon the species' sensitivity and/or low resiliency, individual sea turtles may be experiencing residual effects provided sufficient exposure. Further, it is uncertain whether or how many sea turtle individuals affected by the spill would be present in the CPA when activities first occur as a result of a CPA proposed action. Without any further data than what exist from NMFS and FWS (which have jurisdiction over sea turtles in water and on land, respectively), it is impossible to determine if the spill has led to population-level effects or if sea turtles are experiencing chronic effects or persistent adverse impacts from the spill at the population level. Information is still being gathered to develop a more complete picture of impacts and the length of time for any changed baseline conditions to return to pre-spill conditions (see "Sea Turtle Resources in the Central Planning Area" below). It is also important to note that evaluations have not yet confirmed the cause of death, including whether or not related to the DWH event oil spill.

Sea Turtle Strandings in the Gulf of Mexico

Since March 15, 2011, a notable increase in sea turtle strandings has occurred in the northern GOM, primarily in Mississippi. While turtle strandings in this region typically increase in the spring, the recent increase is a cause for concern. The Sea Turtle Stranding and Salvage Network is monitoring and investigating this increase. The network encompasses the coastal areas of the 18 states from Maine through Texas and includes portions of the U.S. Caribbean. There are many possible reasons for the increase in strandings in the northern GOM, both natural and human caused (USDOC, NMFS, 2011b). No visible external or internal oil was observed in these animals. These sea turtle species include loggerhead, green, Kemp's ridley, and unidentified. As of April 15, 2012, NMFS has identified 106 strandings in Alabama; 208 strandings in Louisiana; and 374 strandings in Mississippi. A CPA proposed action also covers these same areas.

Over the last 2 years, NOAA has documented increased numbers of sea turtle strandings in the northern GOM. Many of the stranded turtles were reported from Mississippi and Alabama waters, and very few showed signs of external oiling (believed to be related to the DWH event). Necropsy results from many of the stranded turtles indicate mortality due to forced submergence, which is commonly associated with fishery interactions. In June 2011, NMFS announced that it will begin scoping for the preparation of a draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (76 FR 37050).

Sea Turtle Resources in the Central Planning Area

The final determinations on damages to sea turtle resources from the DWH event will ultimately be made through the NRDA process. For sea turtles, investigations as part of the NRDA process are under the jurisdiction of NMFS and FWS. The DWH event will allow a better understanding of any realized effects from such a low-probability catastrophic spill. However, the best available information on impacts to sea turtles does not yet provide a complete understanding of the effects of the oil spill and active response/cleanup activities from the DWH event on sea turtles in the GOM and whether these impacts reach a population level. There is also an incomplete understanding of the potential for population-level impacts from the ongoing increased stranding event.

The BOEM concludes that the unavailable information identified above, including that resulting from the DWH event and increased stranding events, could be relevant to reasonable foreseeable significant adverse effects. The OCS activities will be ongoing under active leases (4,377 active leases in CPA as of May 2012), whether or not a CPA proposed action or any other alternative are selected. The BOEM believes that the unavailable information may be essential to a reasoned choice among alternatives, particularly regarding sea turtles affected by the increased stranding and/or DWH events. The NMFS and FWS have jurisdiction for investigating sea turtle impacts, including both the current increased stranding event and the DWH event. To date, NMFS has released only raw data on strandings. The BOEM is therefore unable to determine, at this point and time, what effect (if any) the DWH event had on sea turtles also affected by the increased stranding event. Due to NMFS's and FWS's jurisdiction and role in the investigation, BOEM does not have the ability to obtain its own data on stranded animals. The NRDA process and the increased stranding investigation may take years to complete, and it may be some time before analyses and data are released to the public. Impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

Further, the analyses in this EIS and in **Appendix B** conclude that there is a potential for low-probability catastrophic events to result in significant, population-level effects on affected sea turtle species. The BOEM continues to agree with these conclusions irrespective of any incomplete information, changes to the existing environment from the DWH incident or even the effectiveness of implementation of the improved post-DWH safety and oil-spill-response requirements.

Recent Section 7 Endangered Species Act Consultation

As mandated by the ESA, the BOEM consults with NMFS and FWS on possible and potential impacts from BOEM proposed actions on endangered/threatened species and designated critical habitat under their jurisdiction. Prior consultation with NMFS and FWS on the previous 2007-2012 Multisale EIS was completed in 2007. Following the DWH event on July 30, 2010, BOEMRE requested reinitiation of the previous ESA consultation with both NMFS and FWS. The BOEM and BSEE are developing a more programmatic approach with NMFS and FWS for future ESA consultation that will evaluate BOEM's activities on a more programmatic basis versus a lease sale-specific analysis. The purpose of this coordination is to ensure that NMFS and FWS have the opportunity to review postlease exploration, development and production activities (prior to BOEM and BSEE approval) to ensure all approved plans and permits contain any necessary measures to avoid jeopardizing the existence of any ESA-listed species or precluding the implementation of any reasonable and prudent alternative measures while formal consultation and the development of a Biological Opinion are ongoing.

4.2.1.13.2. Impacts of Routine Events

Background/Introduction

Routine activities resulting from a CPA proposed action have the potential to harm sea turtles, although this potential is unlikely to rise to a level of significance due to the activity already present in the GOM and mitigations that are in place and discussed below. The major impact-producing factors resulting from the routine activities associated with a CPA proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, drillships, and seismic exploration; vessel collisions; and marine debris generated by service vessels and OCS facilities.

Contaminants and Discharges

Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification, but there is uncertainty concerning the possible effects. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (NRC, 1983; API, 1989; Kennicutt, 1995; Kennicutt et al., 1996). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (Neff et al., 1989). Impacts from water degradation are expected to be negligible due to rapid dilution of the discharges, which are regulated by NPDES permits, and due to the wide-ranging habits of sea turtle species in the GOM.

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights; however, anecdotal reports indicate that sea turtles often react to the sound and/or the shadow of an aircraft by diving. It is assumed that aircraft noise can be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided because of noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sound responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been observed noticeably increasing their swimming in response to an operating seismic source at 166 dB re-1µPa-m (McCauley et al., 2000). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). Increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel strikes are a cause of sea turtle mortality in the Gulf (Lutcavage et al., 1997). Stranding data for the U.S. Gulf and Atlantic Coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997). Vessel-related injuries were noted in 13 percent of stranded turtles examined from the GOM and the Atlantic during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5-50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the United States (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles would be impacted.

Explosive Platform Removals

Offshore structures serve as artificial reefs and are sometimes used by sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, green, Kemp's ridley, and hawksbill have also been observed (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). Loggerheads may reside at specific offshore structures for extended periods of time (Rosman et al., 1987b; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987b). Sea turtles probably use platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been observed sleeping under platforms or beside support structures (Hastings et al., 1976; Rosman et al., 1987b; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989 and 1990).

Information about the effects of underwater explosions on sea turtles is limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and suggested that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NMFS conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, turtles within 3,000 ft (914 m) of the platform were rendered unconscious (Klima et al., 1988), although they resumed apparently normal activity 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage as seen in the everted cloacal lining (single rear vent) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for 3 weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed 1 hr. Injured turtles that are capable of swimming may return to the surface, while moribund turtles may sink to the seafloor or drift away from the work site. Unconsciousness renders a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives that was reported to BOEM is two loggerheads during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one loggerhead in 1997 (Gitschlag, official communication, 1999), one loggerhead in 1998 (Shah, official communication, 1998), one loggerhead in 2001 (Gitschlag, official communication, 2001), and two loggerhead deaths in 2010. A total of six additional sea turtles have been captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). The low number of turtles affected by explosive removal of structures may be because of the few turtles that occur in harm's way at the time explosives are detonated, the effectiveness of the monitoring program established to protect sea turtles, and/or the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), NMFS initiated an observer program at explosive removals of structures in State and Federal waters of the GOM. For at least 48 hr prior to detonation, NMFS observers watch for sea turtles at the surface. Helicopter surveys within a 1-mi (1.6-km) radius of the removal site are conducted a minimum of 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath structures.

Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments because of explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995b). Because of its temporary effect and localized nature, biomagnification is unlikely.

In 2005, this Agency petitioned NMFS for incidental-take regulations under the MMPA to address the potential injury and/or mortality of marine mammals that could result from the use of explosives during decommissioning activities. Similarly, this Agency initiated ESA Section 7 Consultation efforts with NMFS to cover potential explosive-severance impacts to threatened and endangered species such as sea turtles (and sperm whales). The ESA Consultation was completed in August 2006 and the final MMPA rule was published in June 2008. The mitigation, monitoring, and reporting requirements from the new ESA Biological Opinion/Incidental Take Statement and MMPA regulations mirror one another and allow explosive charges up to 500 lb (227 kg), internal and external placement, and both above-mudline and below-mudline detonations.

The BOEMRE issued "Decommissioning Guidance for Wells and Platforms" (NTL 2010-G05) to offshore operators. These guidelines specify and reference mitigations requirements in the new ESA and MMPA guidance, and they require that trained observers watch for protected species of sea turtles and marine mammals in the vicinity of the structures to be removed.

Marine Debris

A wide variety of trash and debris is commonly observed in the Gulf. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, 40,580 debris items were collected in a 16-mi (26-km) transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1997). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to the misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1997). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open ocean voyage. Some hatchlings spend their "lost years" in *Sargassum* rafts; ocean currents concentrate or trap floating debris in *Sargassum* (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi (9-15 mi; 15-24 km) east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The GOM had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp's ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The BSEE prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.300). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Effluents are routinely discharged into offshore marine waters and are regulated by the U.S. Environmental Protection Agency's NPDES permits. Information on the contaminants that would be discharged offshore as a result of a CPA proposed action is provided in **Chapter 3.1.1.4**. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification, but there is uncertainty concerning the possible effects. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (NRC, 1983; API, 1989; Kennicutt, 1995; Kennicutt et al., 1996). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (Neff et al., 1989). Very little information exists on the impact of drilling muds on GOM sea turtles (Tucker and Associates, Inc., 1990). Impacts from water degradation are expected to be negligible due to the wide-ranging habits of sea turtle species in the GOM.

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in **Chapters 4.2.1.5.2 and 4.2.1.6**. The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a CPA proposed action because these sensitive resources are protected by several mitigation measures established by BOEM. These mitigation measures include marine protected species NTL's (**Chapter 2.2.2**).

An estimated 94,000-168,000 service-vessel round trips are expected to occur annually as a result of a CPA proposed action. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter operations are expected to be 696,000-1,815,000 (take-offs and landings) per year as a result of a CPA proposed action. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles, and there is the possibility of short-term disruption of activity patterns. Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic would increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

Vessel noise and vessel collisions are impact-producing factors associated with a CPA proposed action that could affect ESA-listed sea turtles. The dominant source of noise from vessels is propeller operation, and the intensity of this noise is largely related to ship size and speed. Vessel noise from activities resulting from a CPA proposed action would produce low levels of noise, generally in the 150- to 170-dB re 1 µPa-m at frequencies below 1,000 Hz. Vessel noise is transitory and generally does not propagate at great distances from the vessel. Also, available information indicates that sea turtles are not thought to rely on acoustics. As a result, NMFS's 2007 Biological Opinion concluded that effects to sea turtles from vessel noise are "discountable" (USDOC, NMFS, 2007b).

Drilling activities would produce sounds transmitted into the water that could be intermittent, sudden, and at times could be high intensity as operations take place. However, sea turtles are not expected to be impacted by this disturbance because NMFS, in their 2007 Biological Opinion, determined that "drilling is not expected to produce amplitudes sufficient to cause hearing or behavioral effects to sea turtles or sperm whales; therefore, these effects are insignificant."

Sea turtles spend at least 3-6 percent of their time at the surface for respiration and perhaps as much as 26 percent of their time at the surface for basking, feeding, orientation, and mating (Lutcavage et al., 1997). Data show that collisions with all types of commercial and recreational vessels are a cause of sea turtle mortality in the GOM (Lutcavage et al., 1997). Stranding data for the U.S. Gulf and Atlantic Coasts, Puerto Rico, and the U.S. Virgin Islands show that, between 1986 and 1993, about 9 percent of living and dead stranded sea turtles had boat strike injuries (Lutcavage et al., 1997). Vessel-related injuries were noted in 13 percent of stranded turtles examined from the GOM and the Atlantic during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. Large numbers of loggerheads and 5-50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997).

There have been no documented sea turtle collisions with drilling and service vessels in the GOM; however, collisions with small or submerged sea turtles may go undetected. Based on sea turtle density estimates in the GOM, the encounter rates between sea turtles and vessels would be expected to be greater in water depths <200 m (656 ft) (USDOC, NMFS, 2007b). To further minimize the potential for vessel strikes, NTL 2012-JOINT-G01 was issued; this NTL clarifies 30 CFR 250.282 and 30 CFR 550.282 and provides NMFS guidelines for monitoring procedures related to vessel strike avoidance measures for sea turtles and other protected species. With the implementation of these measures and the avoidance of potential strikes from OCS vessels, the NMFS 2007 Biological Opinion concluded that the risk of collisions between oil- and gas-related vessels (including those for G&G, drilling, production, decommissioning, and transport) and sea turtles is appreciably reduced, but strikes may still occur. The BOEM and BSEE monitor for any takes that have occurred as a result of vessel strikes and also requires that any operator immediately report the striking of any animal (30 CFR 550.282, 30 CFR 250.282, and NTL 2012-JOINT-G01).

To date, there have been no reported strikes of sea turtles by drilling vessels. Given the scope, timing, and transitory nature of a CPA proposed action and with this established mitigation, the effects to sea turtles from drilling vessel collisions is expected to be negligible.

A total of 168-329 exploration wells and 215-417 producing development wells are projected to be drilled as a result of a CPA proposed action. A total of 35-67 platforms are projected to be installed as a result of a CPA proposed action. Of those, 20-40 are projected to be removed with explosives. These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (e.g., subtle changes in behavior, and interruption of activity), the masking of other sounds (e.g., surf, predators, vessels), and stress (physiological).

Chronic sublethal effects (e.g., stress), resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas from noise disturbance such as G&G activities, could cause declines in survival or fecundity and could result in population declines; however, such declines are not expected. Seismic operations have the potential to harm sea turtles in close proximity to firing airgun arrays, especially if they are directly beneath airguns when surveying begins. The Protected Species Stipulation and NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimize the potential of harm from seismic operations to sea turtles. These mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source.

This Agency published a Programmatic EA on decommissioning operations (USDOI, MMS, 2005) that, in part, addresses the potential impacts of explosive- and nonexplosive-severance activities on OCS energy-related resources, particularly upon marine mammals and sea turtles. Pursuant to 30 CFR 250 Subpart Q, operators must obtain a permit from BSEE before beginning any platform removal or well-severance activities. During the review of the permit applications, terms and conditions of the applicable NMFS Biological Opinion/Incidental Take Statement are implemented for the protection of marine protected species and for the reduction of possible impacts from any potential activities resulting from a CPA proposed action.

In 30 CFR 250 and 30 CFR 550 Subpart B, BOEM and BSEE require operators of Federal oil and gas leases to meet the requirements of the ESA. The regulations outline the environmental, monitoring, and mitigation information that operators must submit with plans for exploration, development, and production. This regulation requires OCS energy-related activities to be conducted in a manner that is consistent with the provisions of the ESA. Actual sea turtle impacts from explosive removals in recent years have been small. The updated pre- and post-detonation mitigations should ensure that injuries remain extremely rare.

Greatly improved handling of waste and trash by industry, along with the annual awareness training required by the marine debris mitigations, is decreasing the plastics in the ocean attributable to OCS energy related activities and is minimizing the devastating effects on sea turtles. Many types of plastic materials end up as solid waste during drilling and production operations. Some of this material is accidentally lost overboard where sea turtles could consume it or become entangled in it. The incidental ingestion of marine debris and entanglement could adversely affect sea turtles. The BSEE propose compliance with the guidelines provided in NTL 2012-BSEE-G01 "Marine Trash and Debris Awareness and Elimination," which appreciably reduces the likelihood of sea turtles encountering marine debris from the proposed activity. The routine activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or populations in the GOM.

Although there will always be some level of incomplete information relevant to the effects from routine activities under a CPA proposed action on sea turtles, BOEM does not believe it is essential to a reasoned choice among alternatives. There is credible scientific information available, and applied using acceptable scientific methodologies, to support the conclusion that any realized impacts would be sublethal in nature and not in themselves be expected to rise to the level of reasonably foreseeable significant adverse (population level) effects. As noted above in the description of the affected environment section, however, BOEM cannot rule out that incomplete or unavailable information on effects of the increased stranding event or DWH event on sea turtles may be essential to a reasoned choice among alternatives (and that this information cannot be obtained within the timeframe contemplated by this NEPA analysis). As such, BOEM acknowledges that impacts from routine activities could be greater on individuals or populations already impacted by the DWH event or increased stranding event. Nevertheless, routine activities are ongoing in a CPA proposed action area as a result of active leases and related activities (there are 4,377 active leases in the CPA as of May 2012). Within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no previous data to suggest that routine activities from the preexisting OCS Program were significantly impacting sea turtles.

Summary and Conclusion

The BOEM has reexamined the analysis for sea turtles and has considered the recent reports cited above and other new information. Because of the mitigations (e.g., BOEM and BSEE proposed compliance with NTL's) described in the above analysis, routine activities (e.g., operational discharges, noise, vessel traffic, and marine debris) related to a CPA proposed action are not expected to have long-term adverse effects on the size and productivity of any sea turtle species or populations in the northern GOM. Lethal effects could occur from chance collisions with OCS service vessels or ingestion of accidentally released plastic materials from OCS vessels and facilities. However, there have been no reports to date on such incidences. Most routine OCS energy-related activities are then expected to have sublethal effects that are not expected to rise to the level of significance.

4.2.1.13.3. Impacts of Accidental Events

This chapter discusses the impacts of accidental events associated with a CPA proposed action on sea turtles. This section treats both the expected accidental spill as well as the low-probability large-volume spill with catastrophic events. Further, general analyses of a catastrophic event in the GOM can also be found in **Appendix B**.

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident.

Oil Spills

In recent years, increased regulation and decreased tolerance of potentially harmful experimentation with endangered species has limited the available data on adverse impacts from events such as oil spills. Much of the best available science about the physiological response of sea turtles (and marine mammals) to oil exposure comes from studies and observations done in the 1990's and earlier. Also, decreasing oil spill occurrence due to increased safety and security requirements for petroleum transport limits the number of field observations of the effects of spilled oil on sea turtles and other marine fauna.

The following key points concerning oil toxicity and impacts on sea turtles are made by Sheginaka (2003):

- Although surprisingly robust when faced with physical damage (shark attacks, boat strikes), sea turtles are highly sensitive to chemical insults such as oil.
- Areas of oil and gas exploration, transportation, and processing often overlap with important sea turtle habitats.
- Sea turtles are vulnerable to the effects of oil at all life stages—eggs, post-hatchlings, juveniles, and adults in nearshore waters.

- Several aspects of sea turtle biology and behavior place them at particular risk, including a lack of avoidance behavior, indiscriminate feeding in convergence zones, and large pre-dive inhalations.
- Oil effects on turtles include increased egg mortality and developmental defects; direct mortality due to oiling in hatchlings, juveniles, and adults; and negative impacts to the skin, blood, digestive and immune systems, and salt glands.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location; hydrocarbon type, dosage, and weathering; impact area; oceanographic and meteorological conditions; season; and life history stages of animals exposed to the hydrocarbons (NRC, 2003). All sea turtle species and life stages are vulnerable to the harmful effects of oil through direct contact or by fouling of their habitats and prey. Van Vleet and Pauly (1987) suggested that discharges of crude oil from tankers were having a significant effect on sea turtles in the eastern GOM. Experiments on the physiologic and clinicopathologic effects of hydrocarbons have shown that major body systems of sea turtles are adversely affected by short exposure to weathered oil. Sea turtles accidentally exposed to oil or tarballs may suffer inflammatory dermatitis, ventilatory disturbance, salt gland dysfunction or failure, red blood cell disturbances, immune responses, and digestive disorders or blockages (Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Direct contact with oil may harm developing turtle embryos. Exposure to hydrocarbons may be fatal, particularly to juvenile and hatchling sea turtles.

Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus (Overton et al., 1983; Van Vleet and Pauly, 1987; Gramentz, 1988; Lutcavage et al., 1995). Witham (1983) found tar sealed the mouth and nostrils of small turtles. Turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). Periocular tissues and other mucous membranes would presumably be most sensitive to contact with hydrocarbons. Skin damage in turtles is in marked contrast to that observed in dolphins, where all structural and biochemical changes in the epidermis were minor and reversible. Changes in the skin are consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Turtles surfacing in an oil spill will inhale oil vapors. Any interference with operation of the lungs would probably reduce a sea turtle’s capacity for sustained activity (aerobic scope) and its dive time, both effects decreasing the turtle’s chance of survival.

Lutcavage et al. (1995) found that operation of the salt gland in sea turtles was disrupted with exposure to hydrocarbons, but the disturbance did not appear until several days after exposure. The salt glands did recover function when tested after 2 weeks of recovery. Prolonged interference with salt gland functioning could have serious consequences since it would interfere with both water balance and ion regulation. Lutcavage et al. (1995) report finding oil in the feces of turtles that swallowed oil in experiments. Van Vleet and Pauly (1987) reported that oil ingested by turtles did not pass rapidly through the digestive tract but was retained within the system for a period of several days, thus increasing the likelihood that toxic components of oil could be assimilated by other internal organs and tissues of the turtle.

Significant changes in blood chemistry following contact with hydrocarbons have been reported (Lutcavage et al., 1995). Hematocrit and hemoglobin concentration decreased slightly during contact; these parameters are critical components of the blood’s oxygen transport system. The most striking hematologic finding was an elevation of white blood cell count, which may indicate a “stress” reaction related to oil exposure and/or toxicity.

Eggs, hatchlings, and small juveniles are particularly vulnerable if contacted (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Female sea turtles crawling through tar to lay eggs can transfer the tar to the nest; this was noted on St. Vincent National Wildlife Refuge in 1994 (USDOI, FWS, 1997). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Embryonic development in an egg may be altered or arrested by contact with oil (Fritts and McGehee, 1982). Fresh oil was found to be highly toxic, especially during the last quarter of the incubation period, whereas aged oil produced no detectable effects. Fritts and McGehee (1982) concluded that oil contamination of nesting beaches would have its greatest impact on nests that were already constructed; nests made on fouled beaches are less likely to be affected, if at all. However, residual oil and tarballs may be integrated into nests by nesting females. Residues may adhere to sand grains where eggs are deposited, later impeding hatchlings from successfully evacuating nests and ultimately leading to their death. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting hydrocarbons because the currents that concentrate oil spills also form the debris mats in which young turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). This would also be true for juvenile sea turtles that are sometimes found in floating mats of *Sargassum*. Oil slicks, slickets, or tarballs moving through offshore waters may foul *Sargassum* mats that hatchling and juvenile sea turtles inhabit, which would conceivably result in the loss of sea turtle habitat or a take. The result of adult sea turtles feeding selectively in surface convergence lines could be prolonged contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). High rates of oil contact in very young turtles suggest that bioaccumulation may occur over their potentially long lifespan. Exposure to hydrocarbons may begin as early as eggs are deposited in contaminated beach sand. A female coming ashore to nest might be fouled with oil or transport existing residues at the driftline to the nest. During nesting, she might push oil mixed with sand into the nest and contaminate the eggs (Chan and Liew, 1988). Assuming olfaction is critical to the process, oil fouling of a nesting area might disturb imprinting of hatchling turtles or confuse the turtles on their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985; Chan and Liew, 1988).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tarballs, and there is no firm evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986). A loggerhead turtle sighted during an aerial survey in the GOM surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of marine turtles. The effect on reproductive success could therefore be significant.

Contact with hydrocarbons may not cause direct or immediate death but cumulative sublethal effects, such as salt gland disruption or liver impairment, could impair the marine turtle's ability to function effectively in the marine environment (Vargo et al., 1986; Lutz and Lutcavage, 1989). Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995). There is evidence of bioaccumulation in sea turtles exposed for longer periods of time. After the Gulf of Iraq war, a stranded green turtle did not appear to have contacted hydrocarbons, but upon necropsy, was found to have large amounts of oil in its liver and stomach tissues (Greenpeace, 1992).

The blowout of the *Ixtoc I* offshore drilling rig in the Bay of Campeche, Mexico, on June 3, 1979, resulted in the release of 500,000 metric tons (140 million gallons) of oil and the transport of this oil into the Gulf of Mexico (ERCO, 1982). Three million gallons of oil impacted Texas beaches (ERCO, 1982). According to the ERCO study, "Whether or not hypoxic conditions could, in fact, be responsible for areawide reductions in [invertebrate] faunal abundance is unclear, however." Of the three sea turtles found dead in the U.S., all had petroleum hydrocarbons in the tissues examined and there was selective elimination of portions of this oil, indicating chronic exposure (Hall et al., 1983). Therefore, the effects of the *Ixtoc* spill on sea turtles in waters off Texas are still unknown.

Spill-Response Activities

In addition to the impacts from contact with hydrocarbons, spill-response activities could adversely affect sea turtle habitat and cause displacement from suitable habitat to inadequate areas. Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings because of predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The damage assessment and restoration plan/environmental assessment for the August 1993 Tampa Bay oil spill also noted that hatchlings that were restrained during the spill response were released on beaches other than their natal beaches, thus potentially losing them from the local nesting population (Florida Dept. of Environmental Protection et al., 1997). Additionally, turtle hatchlings and adults may become disoriented and normal behavior disrupted by human presence as well as industrial activity. Individual turtles covered with oil have been cleaned, rehabilitated, and released (e.g., Florida Dept. of Environmental Protection et al., 1997). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). After passage of OPA 90, seagrass beds and live-bottom communities are expected to receive individual consideration during spill cleanup. Required spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Loggerhead turtle nesting areas in the Chandeleur Islands, Cape Breton National Seashore, and central Gulf Coast States would also be expected to receive special cleanup considerations under these regulations. Little is known about the effects of dispersants on sea turtles and, in the absence of direct testing, impacts are difficult to predict. Dispersant components absorbed through the lungs or gut may affect multiple organ systems and interfere with digestion, excretion, respiration, and/or salt-gland function. Inhalation of dispersant can interfere with function through the surfactant (detergent) effect. These impacts are likely similar to the empirically demonstrated effects of oil alone (Hoff and Shigenaka, 2003).

Proposed Action Analysis

Accidental activities resulting from a CPA proposed action have the potential to harm sea turtles. The major impact-producing factors resulting from the accidental activities associated with a CPA proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include accidental blowouts, oil spills, and spill-response activities. These have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Chronic or acute exposure may result in harassment, harm, or mortality of sea turtles occurring in the northern Gulf. Exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick are expected to most often result in sublethal impacts (e.g., decreased health and/or reproductive fitness, and increased vulnerability to disease) to sea turtles. Sea turtle hatchling exposure to, fouling by, or consumption of tarballs persisting in the sea following the dispersal of an oil slick would likely be fatal. Sea turtle eggs are likely to be lethally impacted by contact with spilled oil (USDOI, NPS, 2011b). The potential effects associated with a low-probability large spill may be more severe than a smaller accidental spill and could potentially contribute to longer-lasting and larger-scale effects. **Appendix B** discuses, in general, the magnitude and duration of the effects possible if the low-probability, large-volume spill was to occur in the GOM.

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters has a 3-5 percent and 9-16 percent probability of impacting Texas State offshore waters, based on a CPA proposed action (**Figure 3-8**). State offshore waters in Louisiana, Mississippi, Alabama and Florida are also estimated for the CPA in this figure. Additionally, the Florida Panhandle offshore waters had a 1-2 percent 30-day probability of a spill risk from a CPA proposed action (**Figure 3-8**).

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring near coastal GOM counties within the CPA proposed action would impact a total of 15 counties/parishes with >0.5 percent probability (**Figure 3-10**). The Chandeleur Islands have a 1-2 percent and 2-3 percent risk of impact from an OCS spill occurrence resulting from a CPA proposed action (**Figure 3-25**). The Tortugas Ecological Reserve and Dry Tortugas have a <0.5 percent and <0.5 percent risk of impact from an OCS spill occurrence resulting from either a CPA proposed action. The Florida Keys National Marine Sanctuary has a <0.5 percent and <0.5-1 percent risk of impact from an OCS spill occurrence resulting from a CPA proposed action (**Figure 3-25**).

In general terms, coastal waters of the CPA area may be contacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 and <1,000 bbl); and a single, large (≥1,000 bbl) spill as a result of the proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters compared with platforms and tankers. Spill estimates for the CPA over a 40-year time period indicate that 234-404 spills with median spill size of <0.024 bbl of oil might be introduced in offshore waters from small spills (≤1 bbl) (**Table 3-12**). An estimated maximum number of 17 spills with a median of between 3 and 130 bbl of oil could be spilled in quantities of a >1 to <1,000 bbl spill event. The actual number of spills that may occur in the future could vary from the estimated number. A spill size group for ≥10,000 bbl was not included in this table because the catastrophic DWH oil spill (4.9 MMbbl released from the well) was the only spill in this size range during 1996-2010; thus, limited conclusions can be made from a single data point (**Table 3-12**).

Because oil spills introduced specifically in coastal waters of Louisiana are assumed to impact adjacent lands, there is likelihood that spilled oil would impact sea turtle nesting beaches. In Louisiana, loggerhead nesting beaches on the Chandeleur Islands are vulnerable to an oil spill originating in adjacent waters; however, the hurricane damage suffered by these islands in the last few years has likely rendered them unsuitable for nesting beaches.

Depending on the timing of the spill's occurrence in coastal waters, its impact and resulting cleanup may interrupt sea turtle migration, feeding, mating, and/ or nesting activity for extended periods (days, weeks, months). Spills originating in or migrating through coastal waters of Texas or Louisiana may impact any of the five sea turtle species inhabiting the Gulf. Kemp's ridley is the most endangered sea turtle species and is strongly associated with coastal waters of Texas and Louisiana. Also, green, hawksbill, loggerhead, and leatherback sea turtles use coastal waters of the western Gulf. Aside from the acute effects noted if sea turtles encounter an oil slick, the displacement of sea turtles to less suitable habitats from habitual feeding areas impacted by oil spills may increase vulnerability to predators, disease, or anthropogenic mortality. A high incidence of juvenile sea turtle foraging occurs along certain coastal regions of the Gulf Coast. Prime examples of known foraging areas for juvenile sea turtles in the Gulf are the Texas Laguna Madre, extending from the Texas-Mexico border to Mansfield Pass, Texas, for green turtles; and Sea Rim State Park, Texas, to Mermentau Pass, Louisiana, for Kemp's ridleys (Renaud, 2001). The interruption of mating and nesting activities for extended periods may influence the recovery of sea turtle populations. For example, a large oil spill could inhibit the mating or nesting activity of the Kemp's ridley sea turtle at Texas beaches by limiting the number of eggs being fertilized or the number of nests being constructed for one or more years.

All neonate sea turtles undertake a passive voyage via oceanic waters following nest evacuation. Depending on the species and population, their voyage in oceanic waters may last 10 or more years. Beaches of the Caribbean Sea and GOM are used as nesting habitat, and hatchlings evacuating these nesting beaches emigrate to oceanic waters seaward of their nesting sites. Surface drifter card data (Lugo-Fernandez et al., 2001) indicate that circulation patterns in the Caribbean Sea and southern GOM may transport neonate and young juvenile sea turtles from these areas to oceanic waters off the coasts of Texas and Louisiana. Moreover, these journeys begin as pulsed events, with many hatchlings emerging and emigrating offshore at the same times. Oceanic OCS waters of the GOM are also inhabited by subadult and adult leatherback and loggerhead sea turtles; however, adults of any endemic sea turtle species may be found offshore. Consequently, intermediate to large spills occurring in these waters may impact multiple turtles, particularly neonate or young juvenile sea turtles associating with oceanic fronts or refuging in *Sargassum* mats where oil slicks, decomposing residues, and tarballs are likely to accumulate. Large spills, particularly those flowing fresh hydrocarbons into oceanic and/or outer continental shelf waters for extended periods (days, weeks, months), pose an increased risk of impacting sea turtles inhabiting these waters. It is noteworthy that such an event may impact entire cohorts originating from nesting beaches in the Caribbean or southern Gulf, as well as those originating from Texas and Louisiana nesting beaches.

There is an extremely small probability that a single sea turtle would encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over 40 years increases the likelihood that an animal would encounter a single slick during the lifetime of an animal; many sea turtle species are long-lived and may traverse throughout waters of the northern Gulf. The web of reasoning is incomplete without considering the abundance (stock or population) of each species inhabiting the Gulf. The likelihood that members of a sea turtle population (e.g., Kemp's ridley) may encounter an oil slick resulting from a single spill during a 40-year period is greater than that of a single individual encountering a slick during its lifetime. It is impossible to estimate precisely what sea turtle species, populations, or individuals would be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to estimating when and where oil spills would occur over a 40-year period.

Given the distribution of available leases and pipelines associated with a CPA proposed action and the distribution of sea turtles in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that a CPA proposed action may introduce

15.825-21.733 BBO and 63.347-92.691 Tcf of gas into Gulf offshore and coastal environments over 40 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers. **Chapter 3.2.1** details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), sea turtles of any life history stage may be exposed via the waters that they drink and swim, as well as via the prey they consume. For example, tarballs may be consumed by sea turtles and by other marine organisms, and eventually bioaccumulate within sea turtles. Although sea turtles may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a sea turtle is exposed to oil resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern GOM would be exposed to residuals of oils spilled as a result of a CPA proposed action during their lifetimes.

In general, on a yearly basis, about 1 percent of strandings identified by the U.S. Sea Turtle Stranding Network are associated with oil (e.g., Teas and Martinez, 1992). Turtles do not always avoid contact with oil (e.g., Lohoefener et al., 1989). Contact with petroleum and consumption of oil and oil-contaminated prey may seriously impact turtles; there is direct evidence that turtles have been seriously harmed by petroleum spills. Oil spills and residues have the potential to cause chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on turtles.

Due to spill response and cleanup efforts, much of an oil spill may be recovered before it reaches the coast. However, cleanup efforts in offshore waters may result in additional harm or mortality of sea turtles, particularly to neonates and juveniles. Oil spills and spill-response activities at nesting beaches, such as beach sand removal and compaction, can negatively affect sea turtles. Although spill-response activities such as vehicular and vessel traffic during nesting season are assumed to affect sea turtle habitats, further harm may be limited because of efforts designed to prevent spilled oil from contacting these areas. Increased human presence could influence turtle behavior and/or distribution, thereby stressing animals and making them more vulnerable to predators, the toxicological effects of oil, or other anthropogenic sources of mortality.

The oil from an oil spill can adversely affect sea turtles by causing soft tissue irritation, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats. The long-term impacts to sea turtle populations are poorly understood but could include decreased survival and lowered reproductive success. The range of toxicity, the degree of sensitivity to oil hydrocarbons, and the effects of cleanup activities on sea turtles are unknown. Impacts from the dispersants may have similar impacts as oil, such as being an irritant to tissues and sensitive membranes as they are known to be in seabirds and marine mammals (NRC, 2005). Sea turtles are vulnerable to oil and dispersants at all life stages (eggs, post-hatchlings, juveniles, sub-adults and adults) and there is no demonstrated avoidance behavior (Shigenaka et al., 2010). The impacts to sea turtles from chemical dispersants could include nonlethal injury (e.g., tissue irritation, chemical burns, and inhalation), long-term exposure through bioaccumulation, infection, and potential shifts in distribution from some habitats (USDOC, NOAA, 2010m; Shigenaka et al., 2010).

During the oil-spill response related to the DWH event, NMFS and FWS undertook an unprecedented attempt to relocate a number of sea turtle nests and eggs that were located on beaches affected, or that were believed to be at risk of, spilled oil (see the discussion in **Chapter 4.2.1.13.1**). This experimental approach had not been attempted on a large scale for any prior spill. The fate of these relocated hatchlings may never be known, since none of the individuals were tagged and tracked. There are concerns over the potential success of this program, given that these species tend to return to their natal beaches as adults to nest. In addition, sea turtle species require at least a decade before they reach sexual maturity. Even in 10 years, data on nestings would likely be inconclusive as it would be impossible to tell which returning females, if any, are from this relocation experiment.

In the 2007 Biological Opinion/Incidental Take Statement, NMFS indicated that a small number of listed species would experience adverse effects as the result of exposure to a large oil spill or ingestion of accidentally spilled oil over the lifetime of a CPA proposed action (USDOC, NMFS, 2007b). However, NMFS did not include the incidental take of listed species due to oil exposure in the Incidental Take Statement, as it is an otherwise unlawful activity. Incidental take, as defined at 50 CFR 402.02, refers only to takings that result from an otherwise lawful activity. The Clean Water Act (33 U.S.C. 1251 *et seq*.), as amended by the Oil Pollution Act of 1990 (33 U.S.C. 2701 *et seq*.), prohibits discharges of harmful quantities of oil, as defined at 40 CFR 110.3, into waters of the United States. Therefore, even though the Biological Opinion (USDOC, NMFS, 2007b; USDOI, FWS, 2007a) considered the effects on listed species by oil spills that may result from a CPA proposed action, those impacts that would result from an unlawful activity (i.e., oil spills) are not specified in the Incidental Take Statement and have no protective coverage under Section 7(o)(2) of the ESA.

The BOEM concludes that there remains incomplete or unavailable information that may be relevant to reasonably foreseeable significant adverse impacts to sea turtles, including those from noncatastrophic spills/accidental events. Since March 15, 2011, a notable increase in sea turtle strandings has occurred in the northern Gulf of Mexico, primarily in Mississippi. While turtle strandings in this region typically increase in the spring, the recent increase is a cause for concern. The Sea Turtle Stranding and Salvage Network is monitoring and investigating this increase. Many of the stranded turtles were reported from Mississippi and Alabama waters, and very few showed signs of external oiling from the DWH event. Necropsy results from many of the stranded turtles indicate mortality due to forced submergence, which is commonly associated with fishery interactions. In June 2011, NMFS announced that it will begin scoping for the preparation of a draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (76 FR 37050). There is incomplete information on impacts to sea turtle populations from the DWH event and whether individuals or populations may be susceptible to greater impacts in light of the increased stranding event or DWH event. Relevant data on the status of and impacts to sea turtle populations from the increased stranding event and DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. The NMFS to date has only released raw data on the number of strandings, and BOEM does not have the ability to investigate these strandings independently. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In the absence of this information, BOEM subject-matter experts have used what scientifically credible information that is available and applied it using accepted scientific methodologies. The BOEM cannot rule out that unavailable or incomplete information on accidental impacts may be essential to a reasoned choice among the alternatives, in light of the increased stranding event and DWH event. Activities that could result in an accidental spill in the CPA would be ongoing whether or not or not a CPA proposed action occurred. As of May 2012, there were 4,377 active leases in the CPA proposed action area that are engaged in, or have the potential to be engaged in, drilling and/or production activities that could result in an accidental spill.

The BOEM is not determining at this point that activities under a CPA proposed action or those already occurring on issued leases are responsible in part or whole for the current increased stranding event. We are also unable to determine, at this point and time, what effect (if any) the DWH event had on sea turtles also affected by the increased stranding event. Instead, we are stating that these determinations cannot be made based on available information. Further, the costs for obtaining data on the effects from the increased stranding event and/or DWH event are exorbitant and will take years to acquire and analyze through the existing NRDA and increased stranding event processes. Impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches.

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action in the CPA have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Impacts on sea turtles from smaller accidental events are likely to affect individual sea turtles in the spill area, but they are unlikely to rise to the level of population effects (or significance) given the size and scope of such spills. Further, the potential remains for smaller accidental spills to occur in the CPA proposed action area, regardless of any alternative selected under this EIS, given there were 4,377 active leases in the CPA, as of May 2012, with either ongoing or the potential for exploration, drilling, and production activities.

For low-probability catastrophic spills, this EIS concludes that there is a potential for a low-probability catastrophic event to result in significant, population-level effects on affected sea turtle species. The BOEM continues to concur with the conclusions from these analyses.

4.2.1.13.4. Cumulative Impacts

This cumulative analysis considers the effects of impact-producing factors related to a CPA proposed action along with impacts of other commercial, military, recreational, offshore, and coastal activities that may occur and adversely affect populations of sea turtles in the same general area of a CPA proposed CPA.

The major impact-producing factors resulting from cumulative OCS energy related activities associated with a CPA proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles and their habitats include marine debris, contaminant spills and spill-response activities, vessel traffic, noise, seismic surveys, and explosive structure removals. Non-OCS energy related activities that may affect sea turtle populations include vessel traffic and related noise (including from commercial shipping, research vessels), military operations, commercial fishing, and pollution. Major impact-producing factors related to a CPA proposed action that may occur are reviewed in detail in **Chapter 4.2.1.13**. Chapters providing supporting material for the sea turtle analysis include **Chapters 4.2.1.1** (air quality), **4.2.1.2** (water quality), **4.2.1.3** (coastal barrier beaches and associated dunes), **4.2.1.5** (seagrass communities), **3.1.1** (offshore impact-producing factors and scenario), **3.1.2** (coastal impact-producing factors and scenario), **3.2** (impact-producing factors and scenario—accidental events), **3.3** (cumulative activities scenario), and **5.5** (Endangered Species Act). The cumulative impact of these ongoing OCS energy-related activities on sea turtles is expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) because these activities may stress and/or weaken individuals of a local group or population and may predispose them to infection from natural or anthropogenic sources.

Sea turtles may be seriously impacted by marine debris, whatever its source. Trash and flotsam generated by the oil and gas industry and other users of the Gulf (Miller and Echols, 1996) is transported around the Gulf and Atlantic via oceanic currents (Plotkin and Amos, 1988; Hutchinson and Simmonds, 1992). Turtles that consume or become entangled in trash or flotsam may become debilitated or die (Heneman and the Center for Environmental Education, 1988). Monofilament line was reported the most common debris to entangle turtles (NRC, 1990). Fishing-related debris has been involved in about 68 percent of all cases of sea turtle entanglement (O'Hara and Iudicello, 1987). Floating plastics and other debris, such as petroleum residues drifting on the sea surface, accumulate in *Sargassum* drift lines commonly inhabited by hatchling sea turtles. These materials could be toxic. In a review of worldwide sea turtle debris ingestion and entanglement, Balazs (1985) found that tar was the most common item ingested. Sea turtles, particularly leatherbacks, are attracted to floating plastic because it resembles food, such as jellyfishes. Ingestion of plastics sometimes interferes with food passage, respiration, and buoyancy and could reduce the fitness of a turtle or kill it (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; Lutz and Alfaro-Shulman, 1992). The BSEE prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.300). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of plastics at sea or in coastal waters.

The BSEE require compliance with the guidelines provided in NTL 2012-BSEE-G01, "Marine Trash and Debris Awareness and Elimination," which appreciably reduces the likelihood of sea turtles encountering marine debris from the proposed activity.

Effluents are routinely discharged into offshore waters and are regulated by the U.S. Environmental Protection Agency's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and, due to USEPA's permit regulations on discharges, are considered to have little effect (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would more likely be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling mud discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web. This could ultimately reduce reproductive fitness or longevity in sea turtles.

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect sea turtle foraging habitat through destruction of seagrass beds and live-bottom communities used by sea turtles (Gibson and Smith, 1999). At the same time, it should be noted that structure installation creates habitat for subadult and adult sea turtles, which may enhance the recovery of some turtle populations.

Since sea turtle habitat in the GOM includes both inshore and offshore areas, sea turtles are likely to encounter spills that may be related to OCS energy development activities or other sources. Oil-spill estimates project that there would be numerous, frequent, small spills; many, infrequent, moderately sized spills; and infrequent, large spills occurring in coastal and offshore waters from 2012 to 2050 (**Table 3-12**). The probability that a sea turtle is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern Gulf may be exposed to residuals of spilled oils. Oil spills can adversely affect sea turtles by toxic ingestion or blockage of the digestive tract, inflammatory dermatitis, ventilatory disturbance, disruption or failure of salt gland function, red blood cell disturbances, immune responses, and displacement from important habitat areas (Witham, 1978; Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Sea turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988). In the past, tanker washings were a major source of oil in GOM waters (Van Vleet and Pauly, 1987). Although disturbances may be temporary, turtles chronically ingesting oil may experience organ degeneration. Exposure to oil may be fatal, particularly to juvenile and hatchling sea turtles. Hatchling and juvenile turtles are particularly vulnerable to contacting or ingesting oil because currents that concentrate oil spills also form the habitat mats in which these turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). There is also evidence that sea turtles feed in surface convergence lines, which could also prolong their contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). Fritts and McGehee (1982) noted that sea turtle eggs were damaged by contact with weathered oil released from the 1979 *Ixtoc* spill. Skin damage in turtles can result in acute or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection and debilitation (Vargo et al., 1986). Captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding oil, or became agitated and demonstrated short submergence levels (Lutcavage et al., 1995). Sea turtles sometimes pursue and swallow tarballs, and there is no conclusive evidence that wild turtles can detect and avoid oil (Odell and MacMurray, 1986; Vargo et al., 1986). A loggerhead turtle sighted during an aerial survey in the GOM surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have an indirect effect on the behavior of sea turtles. Assuming smell is necessary to sea turtle migration, oil-fouling of a nesting area may disturb imprinting of hatchling turtles or confuse turtles during their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985). The effect on reproductive success could therefore be significant.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location, oil type, oil dosage, impact area, oceanographic conditions, and meteorological conditions (NRC, 1985). Eggs, hatchlings, and small juveniles are particularly vulnerable upon contact (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Although many observed injuries and impacts to sea turtles were resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995).

Oil-spill-response activities, such as vehicular and vessel traffic in coastal areas of seagrass beds and live-bottom communities, can alter sea turtle habitat and displace sea turtles from these areas. Effects on seagrass and reef communities have been noted (reviewed by Coston-Clements and Hoss, 1983). Impacting factors include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some resulting impacts from cleanup could include interrupted or deferred nesting, crushed nests, entanglement in booms, and increased mortality of hatchlings because of predation during the extended time required to reach the water (Newell, 1995; Lutcavage et al., 1997; Witherington, 1999). The strategy for cleanup operations should vary, depending on season, recognizing that disturbance to nests may be more detrimental than oil (Fritts and McGehee, 1982). After passage of the Oil Pollution

Act of 1990 (**Chapter 1.3**), these areas are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil.

Increased surfacing places turtles at greater risk of vessel collision. Vessel traffic, particularly supply boats running from shore bases to offshore structures, is one of the industry activities included in a CPA proposed action. Collisions between service vessels or barges and sea turtles would likely cause fatal injuries. It is projected that 94,000-168,000 OCS-related, service-vessel round trips would occur annually in support of OCS activities in the CPA (**Table 3-3**). It is important to note that these numbers take into account all the activities projected to occur from past, proposed, and future lease sales. In response to the terms and conditions of previous NMFS's Biological Opinions, and in an effort to further minimize the potential for vessel strikes, BOEM and BSEE issued NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which clarifies 30 CFR 550.282 and 30 CFR 250.282, respectively, and provides NMFS guidelines for monitoring procedures related to vessel strike avoidance measures for sea turtles and other protected species. Vessel-related injuries were noted in 13 percent of stranded turtles examined from the Gulf and the Atlantic during 1993 (Teas, 1994). Increased vessel traffic in the Gulf increases the probability of sea turtle ship strikes. Regions of greatest concern may be those with high concentrations of recreational boat traffic, such as the many coastal bays in the Gulf. Potential adverse effects from Federal vessel operations in the CPA proposed action area include operations of the U.S. Navy and USCG, which maintain the largest Federal vessel fleets; USEPA; NOAA; and COE. The NMFS has conducted formal consultations with USCG, U.S. Navy, NOAA, and other Federal agencies, including BOEM, on the activities of their vessels or the vessels considered part of any permitted activity. The NMFS has recommended conservation measures for operations of agency, contract or private vessels to minimize impacts on listed species. However, these actions represent the potential for some level of interaction and, in some cases, conservation measures only apply to areas outside the CPA proposed action area. Thus, operations of vessels by Federal agencies within the CPA proposed action area (i.e., U.S. Navy, NOAA, USEPA, and COE) may adversely affect sea turtles. However, the in-water activities of some of those agencies are limited in scope, as they operate a limited number of vessels or are engaged in research/operational activities that are unlikely to contribute a large amount of risk. (The NMFS reported in 2002 that, at that time, there were 14 active scientific research permits for sea turtles.)

Noise from service-vessel and helicopter traffic may cause a startle reaction from sea turtles and produce temporary stress (NRC, 1990). Helicopter traffic would occur on a regular basis. It is projected that 696,000-1,815,000 OCS-related helicopter operations (take-offs and landings) would occur annually in the support of OCS activities in the CPA (**Table 3-3**). The FAA Advisory Circular 91-36D (September 17, 2004) encourages pilots to maintain higher than minimum altitudes over noise-sensitive areas. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas.

Other sound sources potentially impacting sea turtles include seismic surveys and drilling noise. The potential impacts of anthropogenic sounds on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on prey species. Noise-induced stress has not been studied in sea turtles. Seismic surveys use airguns to generate sound pulses, which are a more intense sound than other nonexplosive sound sources. Seismic activities are expected to be primarily annoyance to sea turtles and cause a short-term behavioral response. However, sea turtles are included in the mitigations required of all seismic vessels operating in the GOM, as stated in NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," which minimizes the potential of harm from seismic operations to sea turtles. These mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source.

It is expected that drilling noise will periodically disturb and affect turtles in the GOM. Based on the conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions (such as those produced by operating platforms) could cause increased surfacing and deterrence behavior from the area near the sound source.

Explosive discharges such as those used for BOEM and COE structure removals can cause injury to sea turtles (Duronslet et al., 1986). Although sea turtles far from the site may suffer only disorientation, those near detonation sites could sustain fatal injuries. Injury to the lungs, intestines, and/or auditory system could occur. Other potential impacts include physical or acoustic harassment. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to explosive detonation are considered to be temporary effects. An estimated 707-1,006 explosive structure removals are projected to occur in the CPA (**Table 3-6)** between 2012 and 2051.

To minimize the likelihood of removals occurring when sea turtles may be nearby, BOEM issued guidelines for explosive platform removal to offshore operators. These guidelines include daylight-limited detonation, staggered charges, placement of charges 5 m (15 ft) below the seafloor, and pre- and post-detonation surveys of surrounding waters. With these existing protective measures (NMFS Observer Program and daylight-only demolition) in place, the "take" of sea turtles during structure removals has been limited. This Agency published a Programmatic EA on decommissioning operations (USDOI, MMS, 2005) that, in part, addresses the potential impacts of explosive and nonexplosive severance activities on OCS energy-related resources, particularly upon marine mammals and sea turtles. Pursuant to 30 CFR 250 Subpart Q, operators must obtain a permit from BSEE before beginning any platform removal or well-severance activities. During the review of the permit applications, terms and conditions of the August 2006 NMFS Biological Opinion/Incidental Take Statement are implemented for the protection of marine protected species and to reduce the possible impacts from any potential activities resulting from a CPA proposed action.

In 30 CFR 250 Subpart B, BOEM and BSEE require operators of Federal oil and gas leases to meet the requirements of the ESA. The regulation outlines the environmental, monitoring, and mitigation information that operators must submit with plans for exploration, development, and production. This regulation requires OCS energy-related activities to be conducted in a manner that is consistent with the provisions of the ESA. Actual sea turtle impacts from explosive removals in recent years have been small. The updated pre- and post-detonation mitigations should ensure that injuries remain extremely rare. The NTL 2010-G05, "Decommissioning Guidance for Wells and Platforms," offers further detail.

Non-OCS energy program-related activities include historic overexploitation (which led to listing of the species), commercial fishery interactions, habitat loss, dredging, pollution, vessel strikes, and pathogens. The Gulf Coast is a well-populated and growing area, and development of previously unusable land for residential and commercial purposes is common. Although some areas of the Gulf Coast have begun to cater to ecotourism by better management of resources, other areas continue to increase attractions particularly for tourists, such as jet skis and thrill craft, which may pose a threat to listed species or their habitats. Increased populations often result in increased runoff and dumping. Many areas around the Gulf already suffer from very high contaminant counts due to river and coastal runoff and discharges. Contaminants may accumulate in species or in prey species.

Dredge-and-fill activities occur in many of the coastal areas inhabited by sea turtles. Operations range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation. Dredging operations affect turtles through accidental take and habitat degradation. The construction and maintenance of Federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges move relatively rapidly (compared with sea turtle swimming speeds) and can entrain and kill these species, presumably as the drag arm of the moving dredge overtakes the slower animal. Hopper dredging has caused turtle mortality in coastal areas (Slay and Richardson, 1988). Nearly all sea turtles entrained by hopper dredges are dead or dying when found (NRC, 1990). In addition to direct take, channelization of the inshore and nearshore areas can degrade foraging and migratory habitats via spoil dumping, degraded water quality/ clarity, and altered current flow.

Construction, vehicle traffic, beachfront erosion, and artificial lighting are activities that disturb sea turtles or their nesting beaches (Raymond, 1984; Garber, 1985). Traffic may compress nests and beach cleaning may compact or destroy nests, lowering hatching success (Coston-Clements and Hoss, 1983). Physical obstacles, such as deep tire tracks and expanded sand piles, may obstruct hatchling turtles from entering the sea or increase their stress and susceptibility to predation (Witham, 1995). Obstructions to the high watermark prevent nesting, and breakwalls are the most common and severe type of obstruction. Erosion of nesting beaches results in the loss of nesting habitat. Human interference has hastened erosion in many places. Artificial lighting from buildings, street lights, and beachfront properties may disorient hatchlings, as well as adults (Witherington and Martin, 1996). Females tend to avoid areas where beachfront lighting is most intense; turtles also abort nesting attempts more often in lighted areas. Hatchlings are attracted to lights and may delay their entry into the sea, thereby increasing their vulnerability to terrestrial predators. Condominiums sometimes block sunlight on nesting beaches, which could presumably affect sex ratios of hatchlings (the sex of a turtle is dependent on egg temperature) by increasing the number of males produced (discussed by Mrosovsky et al., 1995). Increased human activities, such as organized turtle watches, on nesting beaches may affect nesting activity (Fangman and Rittmaster, 1994; Johnson et al., 1996).

Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling water systems of electrical generating plants (NRC, 1990). At the St. Lucie nuclear power plant at Hutchinson Island, Florida, large numbers of green and loggerhead turtles have been captured in the seawater intake canal in the past several years. Annual capture levels from 1994 to 1997 ranged from almost 200 to almost 700 green turtles and from about 150 to over 350 loggerheads. Almost all of the turtles were caught and released alive; NMFS estimated the survival rate at 98.5 percent or greater. Other power plants in Florida, Texas, and North Carolina have also reported low levels of sea turtle entrainment. An offshore intake structure may appear as a suitable resting place to some turtles, and these turtles may be subsequently drawn into a cooling system (Witham, 1995). Feeding leatherbacks may follow large numbers of jellyfish into the intake (Witham, 1995). Deaths can result from injuries sustained in transit through the intake pipe, from drowning in the capture nets, and perhaps from causes before entrainment. Thermal effluents from power plants may cause hatchlings to become disoriented and reduce their swimming speed (O'Hara, 1980). These effluents may also degrade seagrass and reef habitats (reviewed by Coston-Clements and Hoss, 1983).

Sand mining, beach renourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing nesting activities. The main causes of permanent nesting beach loss within the GOM are the reduction of sediment transport, rapid rate of relative sea-level rise, coastal construction and development, and recreational use of accessible beaches near large population centers. Crain et al. (1995) reviewed the literature on sea turtles and beach nourishment and found certain problems repeatedly identified. For nesting females, characteristics induced by nourishment can cause (1) beach compaction, which may decrease nesting success, alter nest-chamber geometry, and alter nest concealment; and (2) escarpments, which can block turtles from reaching nesting areas. For eggs and hatchlings, nourishment can decrease survivorship and affect development by altering beach characteristics such as sand compaction, gaseous environment, hydric environment, contaminant levels, nutrient availability, and thermal environment. Additionally, nests can be covered with excess sand if beach nourishment occurs in areas with incubating eggs.

The BOEM has evaluated the use of sand resources for levee, beach, and barrier island restoration projects. Between 1995 and 2006, this Agency provided over 23 million cubic yards of OCS sand for 17 coastal projects, restoring over 90 mi (145 km) of national coastline. As the demand for sand for shoreline protection increases, OCS sand and gravel has become an increasingly important resource. For example, the Louisiana Coastal Area's Ecosystem Restoration Study estimated that about 60 million cubic yards of OCS sand from Trinity Shoal, Ship Shoal, and other sites would be needed for barrier island and shoreline restoration projects in the next 3-5 years. Use of these resources will require coordination with BOEM for appropriate permits. Sea turtles are included in the potential impacts identified for sand dredging projects. Mitigation measures include requiring stipulations to protect sea turtles when it is determined that there is a likelihood of sea turtle presence within the area during the dredging operation and a trailing suction hopper dredge is used.

Human consumption of turtle eggs, meat, or byproducts occurs worldwide and depletes turtle populations (Cato et al., 1978; Mack and Duplaix, 1979). Commercial harvests are no longer permitted within continental U.S. waters, and Mexico has banned such activity (Aridjis, 1990). Since sea turtles are highly migratory species, the taking of turtles in subsistence and commercial sea turtle fisheries is still a concern.

Chronic pollution, including industrial and agricultural wastes and urban runoff, threatens sea turtles worldwide (Frazier, 1980; Hutchinson and Simmonds, 1991). Some turtle species have lifespans exceeding 50 years (Congdon, 1989; Frazer et al., 1989) and are secondary or tertiary consumers in marine environments, creating the potential for bioaccumulation of heavy metals (Hillestad et al., 1974; Stoneburner et al., 1980; Davenport et al., 1990), pesticides (Thompson et al., 1974; Clark and Krynitsky, 1980; Davenport et al., 1990), and other toxins (Lutz and Lutcavage, 1989) in their tissues. Organochlorine pollutants have been documented in eggs, juveniles, and adult turtles (Rybitski et al., 1995). Not all species accumulate residues at the same rate; for instance, loggerheads consistently have higher levels of both PCB's and DDE than green turtles, and it has been hypothesized that the variation is because of dietary differences (George, 1997). Contaminants could stress the immune system of turtles or act as carcinogens indirectly by disrupting neuroendocrine functions (Colborn et al., 1993). In some marine mammals, chronic pollution has been linked with immune suppression, raising a similar concern for sea turtles.

The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. The air space over the GOM is used extensively by the Dept. of Defense for conducting various air-to-air and air-to-surface operations. Eleven military warning areas and five water test areas are located within the Gulf as stated in NTL 2009-G06, "Military Warning and Water Test Areas" (**Figure 2-2**). Additional activities, including vessel operations and ordnance detonation, also may affect sea turtles. Private and commercial air traffic further traverse these areas and have the potential to cause impacts to sea turtles.

Numerous commercial and recreational fishing vessels also use these areas. Tanker imports and exports of crude and petroleum products into the GOM are projected to increase. Crude oil will continue to be tankered into the Gulf for refining from Alaska, California, and the Atlantic. Recreational pursuits can have an adverse effect on sea turtles through propeller and boat strike damage. Private vessels participate in high-speed marine events concentrated in the southeastern U.S. and are a particular threat to sea turtles. The magnitude of the impacts resulting from such marine events is not currently known (USDOC, NMFS, 2002).

The chief areas used by Kemp's ridleys (coastal waters <18 m [59 ft] in depth) overlap with that of the shrimp fishery (Renaud, 1995). A major source of mortality for loggerhead and Kemp's ridleys is capture and drowning in shrimp trawls (Murphy and Hopkins-Murphy, 1989). Crowder et al. (1995) reported that 70-80 percent of turtle strandings were related to interactions with this fishery. Analysis of loggerhead strandings in South Carolina indicated a high turtle mortality rate from the shrimp fishery through an increase in strandings, and that the use of turtle excluder devices could reduce strandings by 44 percent (Crowder et al., 1995). Caillouet et al. (1996) found a significant positive correlation between turtle stranding rates and shrimp fishing intensity in the northwestern GOM. The Kemp's ridley population, because of its distribution and small numbers, is at greatest risk. The NMFS has required the use of turtle excluder devices in southeast U.S. shrimp trawls since 1989. In response to increased numbers of dead sea turtles that washed up along the coasts of Texas, Louisiana, Georgia, and northeast Florida in 1994-1995, and coincident with coastal shrimp trawling activity, NMFS increased enforcement efforts (relative to turtle excluder devices), which decreased the number of strandings. After concerns arose that turtle excluder devices were not adequately protecting larger sea turtles, NMFS issued a Biological Opinion in 2002 that reported an estimated 62,000 loggerhead and 2,300 leatherback sea turtles had been killed as a result of interaction with the shrimp trawls. The Opinion also stated that 75 percent of the loggerhead sea turtles in the GOM were too large to be protected by the turtle excluder devices. Subsequent regulation issued by NMFS in 2003 required larger openings to better protect the larger sea turtles. The use of turtle excluder devices is believed to reduce hard-shelled sea turtle captures by 97 percent. Even so, NMFS estimated that 4,100 turtles may be captured annually by shrimp trawling, including 650 leatherbacks that cannot be released through turtle excluder devices, 1,700 turtles taken in try nets, and 1,750 turtles that fail to escape through the turtle excluder devices. Other fisheries and fishery-related activities are important sources of mortality but are collectively only one-tenth as important as shrimp trawling (NRC, 1990). Turtles may be accidentally caught and killed in finfish trawls, seines, gill nets, weirs, traps, longlines, and driftnets (Hillestad et al., 1982; NRC, 1990; Witzell, 1992; Brady and Boreman, 1994). Various fishing methods used in State fisheries, including trawling, pot fisheries, fly nets, and gillnets, are known to cause interactions with sea turtles. Florida and Texas have banned all but very small nets in State waters. Louisiana, Mississippi, and Alabama have also placed restrictions on gillnet fisheries within State waters, such that very little commercial gillnetting takes place in southeast waters. The State fishery for menhaden in the State waters of Louisiana and Texas is managed by the Gulf States Marine Fisheries Council and is not federally regulated for sea turtle take. Condrey and Rester (1996) reported a hawksbill take in the fishery, and other takes have been reported in the fishery between 1992 and 1999 (DeSilva, 1999).

Sea turtles frequent coastal habitats such as algae and seagrass beds to seek food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980). Coastal areas are also used by juvenile Kemp's ridleys in Louisiana (Ogren, 1989). Submerged vegetated areas may be lost or damaged by activities altering salinity, turbidity, or natural tidal and sediment exchange. Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage nesting beaches and coastal areas used by sea turtles (Agardy, 1990). Abnormally high tides and waves generated by storms may exact heavy mortality on sea turtles by washing them from the beach, inundating them with sea water, or altering the depth of sand covering them. Furthermore, excessive rainfall associated with tropical storms may reduce the viability of eggs. Turtles could be harmed in rough seas by floating debris (Milton et al., 1994). In addition, the hurricane season for the Caribbean and Western Atlantic (June 1-November 1) overlaps the sea turtle nesting season (March through November) (NRC, 1990). Nests are vulnerable to hurricanes during the incubation period as well as when hatchlings evacuate the nest. Hurricanes can cause mortality at turtle nests through immediate drowning from ocean surges, nest burial, or exhumation before hatching, and after hatching as a result of radically altered beach topography.

The greatest surge effect from Hurricane Andrew in 1992 was experienced at beaches closest to the "eye" of the hurricane; egg mortality was 100 percent (Milton et al., 1994). In areas farther from the "eye," the surge was lower and mortality was correspondingly decreased. Sixty-nine percent of eggs on Fisher Island in Miami, Florida, did not hatch after Hurricane Andrew and appeared to have "drowned" during the storm (Milton et al., 1994). Further mortality occurred when surviving turtles suffocated in nests situated in the beach zone where sand had accreted. This subsequent mortality may be reduced if beach topography is returned to normal and beach debris is removed after a hurricane (Milton et al., 1994). Species that have limited nesting ranges, such as the Kemp's ridley, would be greatly impacted if a hurricane made landfall at its nesting beach (Milton et al., 1994). Hurricane Erin in 1995 caused a 40.2 percent loss in hatchling production on the southern half of Hutchinson Island (Martin, 1996). A beach can be completely closed to nesting after a hurricane. For example, at Buck Island Reef National Monument on St. Croix, after Hurricane Hugo in 1989, 90 percent of the shoreline trees on the North Shore were blown down parallel to the water, blocking access to nesting areas (Hillis, 1990). "False crawl ratios" for hawksbill turtles doubled after the hurricane, mostly because of fallen trees and eroded root tangles blocking nesting attempts (Hillis, 1990). Other direct impacts of Hurricane Hugo on sea turtle habitats include the destruction of coral reef communities important to hawksbill and green turtles. Nooks and crannies in the reef used by these turtles for resting were destroyed in some areas (Agardy, 1990). Seagrass beds, which are important foraging areas for green turtles, were widely decimated in Puerto Rico (Agardy, 1990). Indirect effects (contamination of food or poisoning of reef-building communities) on the offshore and coastal habitats of sea turtles include pollution of nearshore waters from storm-associated runoff.

In 2004, Hurricane Ivan took a large toll on oil and gas structures and operations in the GOM and caused widespread damage to the Alabama-Florida Panhandle coast. In 2005, Hurricanes Katrina, Rita, and Wilma reached Category 5 strength in the GOM. These storms caused damage to all five of the Gulf Coast States and damage to structures and operations both offshore and onshore. The actual impacts of these storms on the animals in the Gulf, and the listed species and critical habitat in particular, have not yet been determined and, for the most part, may remain very difficult to quantify. However, some impacts, such as loss of beach habitat, are known to have occurred and will impact sea turtles. The NMFS granted shrimp trawlers a series of 30-day exemptions from Federal turtle excluder device requirements in some State and Federal waters off Alabama, Mississippi, and Louisiana. The exemptions were granted due to debris in the water, which made trawling with turtle excluder devices "impracticable." Although shrimpers were to limit tow times in lieu of using turtle excluder devices, this exemption may have adversely impacted some individual sea turtles. Not only are the impacts themselves difficult to assess, but the seasonal occurrence of impacts from hurricanes is also impossible to predict. Generally, the offshore species and the offshore habitat are not expected to have been severely affected in the long-term. However, species that occupy more nearshore habitats and those that utilize nearshore habitats (sea turtle nesting) may have suffered more long-term impacts.

In late 2002, the Deepwater Ports Act was modified to include the establishment of natural gas ports on the OCS (the Maritime Transportation Security Act of 2002, Public Law 107-295, November 2002). The Deepwater Ports Act requires an applicant to file a deepwater port license application with the Secretary of the U.S. Dept. of Transportation. The USDOT Secretary has delegated the authority to process an application to the USCG and to the Maritime Administration (MARAD). Eighteen Port License Applications have been filed for approval. Sixteen applications were filed for licenses to import LNG, and two applications were filed for licenses to import oil. Eight applications have been approved; of the eight applications that have been approved, seven licenses have been issued to import both LNG and oil, and one license is pending for a LNG port proposed for construction and operation in the GOM. Of the seven licenses issued, two have been surrendered (USDOT, MARAD, 2011b). Elevated concerns over impingement and entrainment of ichthyoplankton have led to development of monitoring requirements for intake and discharge of seawater at LNG ports in the GOM. These requirements include the collection of baseline data and the use of adaptive management practices. The USCG, working with

NOAA and USEPA, formulated monitoring requirements that were included in the February 16, 2005, Record of Decision for the Gulf Landing LNG port. Subsequent Gulf of Mexico LNG port applications are required to follow similar monitoring requirements. **Chapter 3.1.2.1.4** provides further detail on processing facilities.

Unavailable information on the effects to sea turtles from the DWH event and increased stranding events (and thus changes to the sea turtle baseline in the affected environment) makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to reasonably foreseeable significant adverse impacts to sea turtles. For sea turtles occurring in the CPA, BOEM cannot rule out that incomplete or unavailable information may be essential to a reasoned choice among the alternatives for this EIS. Relevant data on the status of the sea turtle population after the increased stranding event and DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Further, there are already scientific processes in place through the NRDA and increased stranding responses to investigate these remaining questions. The NMFS has only released raw data on stranding numbers to date. The BOEM does not have the ability to investigate the sea turtle strandings independently. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

Nevertheless, as of May 2012, there were 4,377 active leases in the CPA with ongoing (or the potential for) exploration, drilling, and production activities. In addition, non-OCS energy-related activities will continue to occur in the CPA irrespective of a CPA proposed action (i.e., fishing, military activities, and scientific research). The potential for effects from changes to the affected environment (post-DWH), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this EIS.

Summary and Conclusion

As described above, few deaths are expected from chance collisions with OCS service vessels, ingestion of plastic material, commercial fishing, and pathogens. Disturbance (noise from vessel traffic and drilling operations) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal during their life cycle. The net result of any disturbance depends upon the size and percentage of the population likely to be affected, the ecological importance of the disturbed area, the environmental and biological parameters that influence an animal's sensitivity to disturbance and stress, or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). As discussed above, lease stipulations and regulations are in place to reduce vessel strike mortalities. As discussed in **Appendix B**, a low-probability, large-scale catastrophic event could have population-level effects on sea turtles.

The effects of a CPA proposed action, when viewed in light of the effects associated with other past, present, and reasonably foreseeable future activities, may result in greater impacts to sea turtles than before the DWH event; however, the magnitude of those effects cannot yet be determined. Nonetheless, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTL's, to minimize these potential interactions and impacts. The operator's reaffirmed compliance with NTL 2012-JOINT-G01 ("Vessel-Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2012-BSEE-G01 ("Marine Trash and Debris Awareness Elimination"), as well as the limited scope, timing, and geographic location of a CPA proposed action, would result in negligible effects from the proposed drilling activities on sea turtles. In addition, NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimizes the potential of harm from seismic operations to sea turtles and marine mammals; these mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source. Therefore, no significant cumulative impacts to sea turtles would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area.

Adverse effects may result from the incremental contribution of a CPA proposed action combined with non-OCS energy-related activities. The biological significance of any mortality or adverse impact would depend, in part, on the size and reproductive rates of the affected populations, as well as the number, age, and size of animals affected. However, as the analyses above indicate, the potential for impacts is mainly focused on the individual, and population-level impacts are not anticipated based on the best available information.

Incremental injury effects from a CPA proposed action on sea turtles are expected to be negligible for drilling and vessel noise and minor for vessel collisions, but it would not rise to the level of significance because of the limited scope, duration, and geographic area of the proposed drilling and vessel activities and the relevant regulatory requirements.

The effects of a CPA proposed action, when viewed in light of the effects associated with other relevant activities, may affect sea turtles occurring in the GOM. With the enforcement of regulatory requirements for drilling and vessel operations and the scope of a CPA proposed action, incremental effects from the proposed drilling activities on sea turtles would be negligible (drilling and vessel noise) to minor (vessel strikes). The best available scientific information indicates that sea turtles do not rely on acoustics; therefore, vessel noise and related activities would have limited effect. Consequently, no significant cumulative impacts would be expected from a CPA proposed actions' activities or as the result of past, present, or reasonably foreseeable oil and gas leasing, exploration, development, and production in the GOM. Even taking into account additional effects resulting from non-OCS energy-related activities, the potential for impacts from a CPA proposed action is mainly focused on the individual. Population-level impacts are not anticipated based on the best available information.

In any event, the incremental contribution of a CPA proposed action would not be likely to result in a significant incremental impact on sea turtles within the CPA; in comparison, non-OCS-related activities, such as overexploitation, commercial fishing, and pollution, have historically proved to be a greater threat to sea turtles.

4.2.1.14. Diamondback Terrapins

4.2.1.14.1. Description of the Affected Environment

Diamondback terrapins occur in 16 states along the Atlantic and Gulf Coasts; the coastline of Florida represents approximately 20 percent of their full range (Butler et al., 2006). The primary subspecies of terrapin that occurs in the CPA and that is a Federal species of concern is the Mississippi diamondback terrapin (*Malaclemys terrapin pileata*). The Mississippi diamondback terrapin (listed November 15, 1994) has a range that includes Louisiana, Mississippi, Alabama, Georgia, and Florida. Another subspecies that occurs in part of the CPA and that is a Federal species of concern is the Texas diamondback terrapin (*Malaclemys terrapin littoralis*; listed November 15, 1994), which has a range from Louisiana through Texas (USDOI, FWS, 2011a).

"Species of concern" is an informal term that refers to those species that might be in need of concentrated conservation actions. Such conservation actions vary depending on the health of the populations and degree and types of threats. At one extreme, there may only need to be periodic monitoring of populations and threats to the species and its habitat. At the other extreme, a species may need to be listed as a Federal threatened or endangered species under the ESA. Species of concern receive no legal protection above those already afforded the species under other laws, and the use of the term does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species. At the present time, the diamondback terrapin is neither a listed species nor a candidate for listing under the ESA.

Terrapins inhabit brackish waters, including coastal marshes, tidal flats, creeks, and lagoons behind barrier beaches (Hogan, 2003). Juveniles spend the first years of their life under mats of tidal wrack and flotsam. Terrapins meet the osmotic challenges of a saline environment with several behavioral, physiological, and anatomical adaptations (e.g., low skin permeability to salts, powerful lachrymal salt gland, sloping jaw to drink water in thin layers, and feeding in fresh water more than salt water) (Cowan, 1990; U.S. Dept. of the Army, COE, 2002a). Their diet consists of fish, snails, worms, clams, crabs, and marsh plants (Cagle, 1952; Butler et al., 2006).

Similar to Mississippi and Texas terrapins, female Florida terrapins (*Malaclemys terrapin tequesta*) on the east coast reach sexual maturity at a plastron length of 135 mm (5 in) or 4-5 years of age; male

Florida terrapins mature at 95 mm (4 in) about age 2-3 years (Butler et al., 2006). Although not definitively known, Texas and Mississippi terrapins are expected to have similar life cycles. Reproductive activities vary throughout the terrapin range. Courtship and mating occur in March and April, and the nesting season extends through July, with possibly multiple clutches (U.S. Dept. of the Army, COE, 2002a; Butler et al., 2006). Terrapins nest on dunes, beaches, sandy edges of marshes, islands, and dike roads (Roosenburg, 1994). The common factor for proper egg development is sandy soil, which does not clog eggshell pores, thus allowing sufficient gas exchange between the developing embryo and the environment (Roosenburg, 1994). Nesting occurs primarily in the daytime during high tide on high sand dunes with gentle slopes and minimal vegetation (Burger, 1977). Clutch size ranges from 4 to 22 eggs, and incubation time ranges from 61 to 104 days (Butler et al., 2006; Burger, 1977). Female terrapins may nest 2-3 times in the same nesting season. Gender determination is temperature dependent. Hatching occurs from July through October in northeastern Florida (Butler et al., 2004).

Severely depleted by commercial harvest for food a century ago, diamondback terrapins are currently threatened by drowning in crab pots, development of shoreline habitats and nesting beaches, predation of nests and adults, boat strikes, and road mortality (Butler et al., 2006). Spending most of their lives at the aquatic-terrestrial boundary in estuaries, terrapins are susceptible to habitat destruction (including development), erosion, and could be affected by accidental events, such as direct catastrophic oil contact and cleanup efforts. Tropical storms, hurricanes, and beach erosion threaten their preferred nesting habitats. The actual impacts of these storms on the animals in the Gulf and the listed species have not yet been determined and, for the most part, may remain very difficult to quantify. However, some impacts, such as the loss of beach habitat, are known to have occurred and would impact terrapin populations that would have used those areas for nesting beaches.

Deepwater Horizon Event

The DWH event and associated oil spill may have impacted the terrapin community and associated brackish habitats. According to OSAT-2 (2011), possible environmental effects from the DWH event could occur within terrapin marsh habitat via food or from nesting habitat since no active intervention (natural remediation) is the preferred protocol. Terrapins are omnivores, preferring snails, clams, mussels, crabs, insects, fish, worms, and vegetation (Butler et al., 2006).

The *Deepwater Horizon* Unified Command reports daily fish and wildlife collection reports that include turtles; this can be found at RestoreTheGulf.gov (2012). As of April 18, 2012, two other reptiles (not yet identified as terrapin and other than sea turtles) have been collected in the CPA (RestoreTheGulf.gov, 2012). There is photographic evidence of one terrapin found oiled on Grand Terre Island, Louisiana, on June 8, 2010 (Coastal Protection and Restoration, 2012). It is not clear whether this terrapin was included with the two reptiles collected in the CPA, as described on RestoreTheGulf.gov (2012).

As data continue to be gathered and impact assessments completed, a better characterization of the full scope of impacts to the terrapin populations in the GOM from the DWH event will be available. As data continue to be gathered and impact assessments completed, a better characterization of the full scope of impacts to the terrapin populations in the GOM from the DWH event will be available.

The BOEM concludes that there remains incomplete or unavailable information regarding diamondback terrapins that could be relevant to reasonable foreseeable significant adverse effects. This includes information that may be forthcoming regarding impacts from the DWH event. The OCS activities will be ongoing under active leases (4,377 active leases in CPA as of May 2012), whether or not a CPA proposed action or any other alternative is selected. However, BOEM believes that the unavailable information may be essential to a reasoned choice among alternatives, particularly to the extent that diamondback terrapins were affected by the DWH event. The FWS has jurisdiction for investigating terrrapin impacts from the DWH event through the NRDA process. To date, there are no data available on impacts to terrapins from the DWH event. The BOEM is therefore unable to determine, at this point and time, what effect (if any) the DWH event had on terrapins. The NRDA process may take years to complete. Impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

Diamondback Terrapin Resources in the Central Planning Area

The final determinations on damages to diamondback terrapin resources from the DWH event will ultimately be made through the NRDA process. The DWH event will ultimately allow a better understanding of any realized effects from such a low-probability catastrophic spill. However, the best available information on impacts to diamondback terrapins does not yet provide a complete understanding of the effects of the oil spilled and active response/cleanup activities from the DWH event on diamondback terrapins as a whole in the GOM and whether these impacts reach a population level.

4.2.1.14.2. Impacts of Routine Events

Background/Introduction

The major impact-producing factors resulting from the routine activities associated with a CPA proposed action that may affect the Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) include beach trash and debris generated by service vessels and OCS facilities, efforts undertaken for the removal of marine debris or for beach restoration, and vessel traffic with associated habitat erosion.

Proposed Action Analysis

The major routine impact-producing factors associated with a CPA proposed action that may affect terrapins include beach trash and debris generated by service vessels and OCS facilities, efforts undertaken for the removal of marine debris or for beach restoration, and vessel traffic with associated habitat erosion. Greatly improved handling of waste and trash by industry, along with the annual awareness training required by the marine debris mitigations, is decreasing the plastics in the ocean and minimizing the devastating effects on wildlife. The incidental ingestion of marine debris and entanglement could adversely affect terrapins. The BSEE requires compliance with the established guidelines provided in NTL 2012-BSEE-G01, "Marine Trash and Debris Awareness and Elimination," which appreciably reduces the likelihood of encountering marine debris from a CPA proposed action. A proposed action is expected to contribute negligible marine debris or disruption to terrapin habitat. Unless properly regulated, personnel removing marine debris may temporarily disturb terrapins or trample nesting sites. Due to the extended distance from shore, most impacts associated with the OCS Program are not expected to impact terrapins or their habitat.

There have been no documented terrapin collisions with drilling and service vessels in the GOM. To further minimize the potential for vessel strikes, BOEM and BSEE issued NTL 2012-JOINT-G01, which clarifies 30 CFR 550.282 and 30 CFR 250.282 and which provides NMFS guidelines for monitoring procedures related to vessel strike avoidance measures. The BOEM and BSEE monitor for any takes that have occurred as a result of vessel strikes and also requires that any operator immediately report the striking of any marine animal (30 CFR 550.282, 30 CFR 250.282, and NTL 2012-JOINT-G01). Other potential impacts that are indirectly associated with OCS energy-related activities are wake erosion of terrapin habitat resulting from vessel traffic and additional onshore development. However, only a small amount of the routine dredging done in coastal areas would be directly or indirectly due to a CPA proposed action. **Chapter 4.2.1.4.2** provides further detail on routine activities associated with marsh loss.

Little or no damage is expected to the physical integrity, species diversity, or biological productivity of terrapin habitat as a result of a CPA proposed action.

Although there will always be some level of incomplete information on the effects from routine activities under a CPA proposed action on diamondback terrapin, there is credible scientific information, applied using acceptable scientific methodologies, to support the conclusion that any realized impacts from routine activities would be sublethal in nature and not in themselves rise to the level of reasonably foreseeable significant adverse (population-level) effects. Because completion of the NRDA process may be years away, BOEM cannot definitively determine if the information resulting from the process may be essential to a reasoned choice among alternatives. Routine activities, however, will be ongoing in the CPA proposed action area as a result of active leases and related activities. As of May 2012, there are 4,377 active leases in the CPA. Within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that routine activities from the preexisting OCS Program are significantly impacting diamondback terrapin populations. As such, even with this uncertainty, the potential impacts from routine activities associated with a CPA proposed action are unlikely to result in significant, population-level impacts on diamondback terrapins due to their distance from most offshore activities and the limited potential for activities occurring in or near their habitat (0-1 pipeline landfalls and other coastal infrastructure, which is subject to permitting and location requirements). Therefore, a fuller understanding of any incomplete or unavailable information on the effects of routine activities is likely not essential to make a reasoned choice among the alternatives.

Summary and Conclusion

Adverse impacts due to routine activities resulting from a CPA proposed action are possible but unlikely. Because of the greatly improved handling of waste and trash by industry, and the annual awareness training required by the marine debris mitigations, the plastics in the ocean are decreasing and the devastating effects on offshore and coastal marine life are minimizing. The routine activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any terrapin species or population in the GOM. Most routine OCS energy-related activities are expected to have sublethal effects, such as behavioral effects, that are not expected to rise to the level of significance to the populations.

4.2.1.14.3. Impacts of Accidental Events

Background/Introduction

The major impact-producing factors resulting from the accidental events associated with a CPA proposed action that may affect the Mississippi diamondback terrapins (*Malaclemys terrapin pileata*) include offshore and coastal oil spills and spill-response activities. Potential impacts from a low-probability catastrophic spill are addressed in **Appendix B**.

Proposed Action Analysis

Accidental blowouts, oil spills, and spill-response activities resulting from a CPA proposed action have the potential to impact small to large numbers of terrapins within their habitat, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of terrapins in the Gulf may be exposed to residuals of oils spilled as a result of a CPA proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to terrapins occurring in the GOM. In the most likely scenarios, exposure to hydrocarbons persisting within the wetlands following the dispersal of an oil slick could result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease). Terrapin hatchling exposure to, fouling by, or consumption of tarballs persisting inland following the dispersal of an oil slick could likely be fatal but unlikely.

Burger (1994) described the behavior of 11 female diamondback terrapins that were oiled during the January 1990 spill of No. 2 fuel oil in Arthur Kill, New York. The terrapins were hibernating at the time of the spill, and when they emerged from hibernation, they were found to be oiled. The terrapins voided oil from their digestive tracks for 2 weeks in rehabilitation. At 3 weeks, the terrapins scored low on strength tests and were slow to right themselves when placed on their backs. At 4 weeks, they developed edema and appetite suppression. Eight of the 11 died; these animals had traces of oil in their tissues and exhibited lesions in their digestive tract consistent with oil exposure (Burger, 1994).

The DWH event and associated oil spill may have potentially impacted the terrapin community. Impacts from a catastrophic spill may impact terrapin communities (**Appendix B**). Impacts can be either direct (mortality or injury) or indirect (e.g., reduced prey availability); however, most impacts cannot be quantified at this time. The best available information does not provide a complete understanding of the effects of the spilled oil and active response/cleanup activities on the potentially affected terrapin environment.

Accidental blowouts, oil spills, and spill-response activities resulting from a CPA proposed action have the potential to impact small to large numbers of terrapins within their habitat, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of terrapins in the GOM may be exposed to residuals of oils spilled as a result of a CPA proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to terrapins occurring in the Gulf. In most foreseeable cases, exposure to hydrocarbons persisting within the wetlands following the dispersal of an oil slick could result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease). Terrapin hatchling exposure to, fouling by, or consumption of tarballs persisting inland following the dispersal of an oil slick would likely be fatal but unlikely. Impacts from the dispersants are unknown, but they may have similar irritants to tissues and sensitive membranes as they are known to have had on seabirds and sea turtles (NRC, 2005). The impacts to diamondback terrapins from chemical dispersants could include nonlethal injury (e.g., tissue irritation and inhalation), long-term exposure through bioaccumulation, and potential shifts in distribution from some habitats.

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters has a 3-5 percent and 9-16 percent probability of impacting Texas State offshore waters, based on a CPA proposed action (**Figure 3-9**). State offshore waters in Louisiana, Mississippi, Alabama, and Florida are also estimated for the CPA in **Figure 3-9**. In addition, the Florida Panhandle offshore waters had a 1-2 percent 30-day probability of a spill risk from a CPA proposed action (**Figure 3-9**).

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring near coastal GOM counties within a CPA proposed action would impact a total of 15 counties/parishes with >0.5 percent probability (**Figure 3-11**). The Chandeleur Islands have a 1-2 percent and 2-3 percent risk of impact from an OCS spill occurrence resulting from a CPA proposed action (**Figure 3-25**). The Tortugas Ecological Reserve and Dry Tortugas have a <0.5 percent (10-day probability) and <0.5 percent (30-day probability) risk of impact from an OCS spill occurrence resulting from a CPA proposed action. The Florida Keys National Marine Sanctuary has a <0.5 percent and <0.5-1 percent (10- and 30-day probabilities) risk of impact from an OCS spill occurrence resulting from a CPA proposed action (**Figure 3-25**).

In general terms, coastal waters of CPA may be contacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 and <1,000 bbl); and a single, large (≥1,000 bbl) spill as a result of a CPA proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters compared with platforms and tankers. Spill estimates for the CPA over a 40-year period indicate 234-404 spills with median spill size of <0.024 bbl of oil might be introduced in offshore waters from small spills (≤1 bbl) (**Table 3-12**). An estimated maximum 17 spills with a median size of between 3 and 130 bbl of oil could be spilled in quantities of a >1 to <1,000-bbl spill event. The actual number of spills that may occur in the future could vary from the estimated number. A spill size group for ≥10,000 bbl was not included in **Table 3-12** because the catastrophic DWH oil spill (with approximately 4.9 MMbbl released from the well) was the only spill in this size range during 1996-2010, and thus, limited conclusions can be made from a single data point (**Table 3-12**).

The BOEM concludes that there is incomplete or unavailable information that may be relevant to reasonably foreseeable significant adverse impacts from noncatastrophic spills/accidental events to terrapins that were potentially impacted by the DWH event. For example, there is incomplete information on impacts to terrapin populations from the DWH event and whether individuals or populations may be susceptible to greater impacts in light of the DWH event. Relevant data on the status of and impacts to terrapin populations from the DWH event is being developed through the NRDA process and may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. No data on terrapins impacted by the DWH event have been released. It is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In the absence of this information, BOEM subject-matter experts have used what scientifically credible information is available and applied it using accepted scientific methodologies. Activities that could result in an accidental spill in the CPA would be ongoing whether or not a CPA proposed action occurred. As of May 2012, there are 4,377 active leases in the CPA that are engaged in, or have the potential to be engaged in, exploration, drilling, and/or production activities that could result in an accidental spill.

Summary and Conclusion

Impacts on diamondback terrapins from smaller accidental events are likely to affect individual diamondback terrapins in the spill area, as described above, but are unlikely to rise to the level of population effects (or significance) given the probable size and scope of such spills. Further, the potential remains for smaller accidental spills to occur in a CPA proposed action area, regardless of any alternative selected under this EIS, given there are 4,377 active leases (as of May 2012) already in this area with either ongoing or the potential for exploration, drilling, and production activities.

The analyses in this EIS and in **Appendix B** conclude that there is a low probability for catastrophic spills, and **Appendix B** concludes that there is a potential for a low-probability catastrophic event to result in significant, population-level effects on affected diamondback terrapin species. The BOEM continues to concur with the conclusions from these analyses.

For those terrapin populations that may not have been impacted by the DWH event, it is unlikely that a future accidental event related to a CPA proposed action would result in significant impacts due to the distance of most terrapin habitat from offshore OCS energy-related activities. A low-probability catastrophic event of the size and type that could reach these habitats is discussed in **Appendix B**.

4.2.1.14.4. Cumulative Impacts

Background/Introduction

The major impact-producing factors that may affect the Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) include oil spills and spill-response activities, alteration and reduction of habitat and consumption of trash and debris.

Proposed Action Analysis

Most spills related to a CPA proposed action, as well as oil spills stemming from import tankering and prior and future lease sales, are not expected to contact terrapins or their habitats. Cumulative activities posing the greatest potential harm to terrapins are non-OCS energy-related factors (i.e., coastal spills) and natural catastrophes (i.e., hurricanes and tropical storms), which, in combination, could potentially deplete some terrapin populations to unsustainable levels. The incremental contribution of a CPA proposed action to cumulative impacts on the terrapin is expected to be minimal.

Spending most of their lives within their limited home ranges at the aquatic-terrestrial boundary in estuaries, terrapins are susceptible to habitat destruction (i.e., urban development, subsidence, sea-level rise, direct oil contact, and associated cleanup efforts). Habitat loss has the potential to increase terrapin vulnerability to predation and to increase competition. Behavioral effects and nonfatal exposure to or intake of OCS energy-related contaminants or discarded debris may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. Even after the oil is no longer visible, terrapins may still be exposed while they forage in the salt marshes lining the edges of estuaries where oil may have accumulated under the sediments and within the food chain (Burger, 1994; Roosenburg et al., 1999). Nests can also be disturbed or destroyed by cleanup efforts.

Habitat destruction, road construction, and drowning in crab traps are the most recent threats to diamondback terrapins. In the 1800's, populations declined due to overharvesting for meat (Hogan, 2003). Tropical storms, hurricanes, and beach erosion threaten their preferred nesting habitats. Destruction of the remaining habitat due to a catastrophic spill and response efforts could drastically affect future population levels and reproduction. Characteristics of terrapin life history render this species especially vulnerable to overharvesting and habitat loss. These characteristics include low reproductive rates, low survivorship, limited population movements, and nest site fidelity year after year.

Impacts can be either direct (mortality or injury) or indirect (e.g., reduced prey availability); however, most impacts cannot be quantified at this time. As discussed in **Appendix B**, a low-probability catastrophic event could have population-level effects on diamondback terrapins. The best available information does not provide a complete understanding of the effects of the spilled oil and active response/cleanup activities related to the DWH event on the potentially affected terrapin environment; however, the CPA estuarine environments were affected by the DWH event.

The effects of a CPA proposed action, when viewed in light of the effects associated with other past, present, and reasonably foreseeable future activities may result in greater impacts to diamondback terrapins than before the DWH event; however, the magnitude of those effects cannot yet be determined. Nonetheless, to mitigate potential impacts from OCS-related energy activities, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTL's, to minimize these potential interactions and impacts. The operator's reaffirmed compliance with NTL 2012-JOINT-G01 ("Vessel-Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2012-BSEE-G01 ("Marine

Trash and Debris Awareness and Elimination"), as well as the limited scope, timing, and geographic location of a CPA proposed action, would result in negligible effects from the proposed drilling activities on diamondback terrapins. Therefore, no significant cumulative impacts to diamondback terrapins would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area.

Unavailable information on the effects to diamondback terrapins, including those that may have resulted from the DWH event (and thus changes to the diamondback terrapin baseline in the affected environment), make an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to diamondback terrapins. Relevant data on the status of diamondback terrapin populations after the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches. Nevertheless, BOEM believes that incomplete or unavailable information regarding effects of the DWH event on terrapins is not essential to a reasoned choice among alternatives in the cumulative effects analysis. The rate of current and historic loss of terrapin habitat in Louisiana, for example, far exceeds the potential impacts to terrapin habitat from the DWH event.

Summary and Conclusion

Diamondback terrapins have experienced impacting pressures from habitat destruction, road construction, drowning in crab traps, and past overharvesting resulting in historical reductions in their habitat range and declines in populations. Inshore oil spills from non-OCS energy-related sources are potential threats to terrapins in their brackish coastal marshes. Pipelines from offshore oil and gas and other shoreline crossings have contributed to marsh erosion. However, a CPA proposed action includes only limited shoreline crossings, and modern regulations require mitigation of wetland impacts. Low-probability catastrophic offshore oil spills could affect the coastal marsh environment but such events are rare occurrences and may not reach the shore, even if they do occur. Therefore, the incremental contribution of a CPA proposed action is expected to be minimal compared with non-OCS activities. The major impact-producing factors resulting from the cumulative activities associated with a CPA proposed action that may affect the diamondback terrapin include oil spills and spill-response activities, alteration and reduction of habitat, and consumption of trash and debris. Due to the extended distance from shore, impacts associated with activities occurring in the OCS Program are not expected to impact terrapins or their habitat. No substantial information was found at this time that would alter the overall conclusion that cumulative impacts on diamondback terrapins associated with a CPA proposed action is expected to be minimal.

The BOEM has considered this assessment and has reexamined the cumulative analysis for diamondback terrapins and the cited new information. Based on this evaluation, conclusions in these analyses on the effects to diamondback terrapins remain unchanged in regards to routine activities (no potential for significant adverse effects) and accidental spills (potential for significant adverse effects).

In addition, non-OCS energy-related activities (i.e., crabbing, fishing, military activities, scientific research, and shoreline development) will continue to occur in the CPA irrespective of a CPA proposed action. The potential for effects from changes to the affected environment (post-DWH), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this EIS. Impacts on diamondback terrapins from either smaller accidental events or low-probability catastrophic events will remain the same.

Overall, within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the pre-existing OCS Program are significantly impacting diamondback terrapin populations. Non-OCS energy-related activities will continue to occur in the CPA irrespective of a CPA proposed lease sale (i.e., crabbing, fishing, military activities, scientific research, and shoreline development). Therefore, in light of the above analysis of a CPA proposed action and its impacts, the incremental effect of a CPA proposed action on diamondback terrapins populations is not expected to be significant when compared with historic and current non-OCS energy-related activities, such as habitat loss, overharvesting, crabbing, and fishing.

4.2.1.15. Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

An impact from consumption of beach trash and debris associated with a CPA proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. While potential spills that could result from a CPA proposed action are not expected to contact beach mice or their habitats, large-scale oiling of beach mice could result in local extinction and, if not properly regulated and if all response personnel are not completely trained (on short notice if necessary), oil-spill-response and cleanup activities could have a significant impact to the beach mice and their habitat. Cumulative activities posing the greatest potential harm to beach mice are non-OCS factors and natural catastrophes, which, in combination, could potentially deplete some beach mice populations to unsustainable levels. The expected incremental contribution of a CPA proposed action to the cumulative impacts is negligible.

4.2.1.15.1. Description of the Affected Environment

Hall (1981) recognizes 16 subspecies of field mouse (*Peromyscus polionotus*), 8 of which are collectively known as beach mice. Of Gulf Coast subspecies, the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice occupy restricted habitats in the mature coastal dunes of Florida and Alabama. All four mice are listed as endangered: the Alabama subspecies in Alabama (listed June 6, 1985); and the Perdido Key subspecies (June 6, 1985), St. Andrew subspecies (December 18, 1998), and Choctawhatchee subspecies (June 6, 1985) in Florida (USDOI, FWS, 2010e). Ecological data relating to the listing and critical habitat of the four subspecies can be found in USDOI, FWS (1985a and b, and 1998). Current critical habitat for beach mouse can be found in USDOI, FWS (2010f) as follows: Alabama subspecies (pp. 326-337), Choctawhatchee subspecies (pp. 337-381), Perdido Key subspecies (pp. 381-404), and St. Andrew subspecies (pp. 415-465).

Beach mice have such dynamic populations that population estimates based on numbers of individuals are rarely made (Frater, official communication, 2011a). It is too labor intensive. Instead, populations are generally estimated by acres of occupied habitat. At the present time, all beach mouse subspecies populations are well distributed; therefore, all critical habitat units are occupied, with two exceptions. One exception is for Choctawhatchee beach mouse, which does not occupy two isolated State parks: Henderson (96 ac; 39 ha) and St. Andrew (113 ac; 46 ha); this total of 209 ac (85 ha) can be subtracted from the overall acres of designated critical habitat. The other exception is for the St. Andrew beach mouse, which does not currently occupy the Palm Point Unit; therefore, 162 ac (66 ha) can be subtracted from the overall acres of designated critical habitat. For the Alabama beach mouse, critical habitat is not designated for the entire range of the Alabama beach mouse; therefore, the occupied range of the Alabama beach mouse is used as the population estimate. The current estimate is 2,375 ac (961 ha) on Fort Morgan and 130 ac (53 ha) at Gulf State Park, in Gulf Shores. Resulting total areas of occupied habitat for the four species of beach mice are as follows: 2,505 ac (1,014 ha) for the Alabama beach mouse; 1,300 ac (525 ha) for the Perdido Key beach mouse; 2,195 ac (886 ha) for the Choctawhatchee beach mouse; and 2,328 ac (940 ha) for the St. Andrew beach mouse (Frater, official communication, 2011a; Leblanc, official communication, 2011; USDOI, FWS, 2010f).

Continued monitoring of populations of all subspecies along the Gulf Coast between 1985 and the present indicates that approximately 32.3 mi (52 km) of coastal dune habitat are now occupied by the four listed subspecies (1/3 of historic range). Beach mice were listed because of the loss of coastal habitat from human development. The reduced distribution and numbers of beach mice have continued because of multiple habitat threats over their entire range (coastal development and associated human activities, military activities, coastal erosion, and sea states caused by severe weather). Development of beachfront real estate along coastal areas and catastrophic alteration by hurricanes are the primary contributors to loss of habitat. Destruction of Gulf Coast sand dune ecosystems for commercial and residential development has destroyed about 60 percent of original beach mouse habitat (Holliman, 1983). Recent studies indicate that this continues to be a problem (Douglass et al., 1999; South Alabama Regional Planning Commission, 2001).

The inland extent of beach mouse habitat may vary depending on the configuration of the sand dune system and the vegetation present. There are commonly several rows of dunes paralleling the shoreline and within these rows there are generally three types of microhabitat. The first microhabitat is the frontal dunes (from the beach face proceeding inland, these compose the primary and secondary dunes). These features are sparsely vegetated with widely scattered coarse grasses including sea oats (*Uniola paniculata*), bunch grass (*Andropogon maritimus*), and beach grass (*Panicum amarum* and *P. repens*), and with seaside rosemary (*Ceratiola ericoides*), beach morning glory (*Ipomoea stolonifera*), and railroad vine (*I. Pes-caprae*). Primary and secondary dunes only differ in location relative to the beach. The second microhabitat is the higher rear scrub dunes (tertial dunes), which support growth of slash pine (*Pinus elliotti*), sand pine (*P. clausa*), and scrubby shrubs and oaks, including yaupon (*Ilex vomitoria*), marsh elder (*Iva sp*.), scrub oak (*Quercus myrtifolia*), and sand-live oak (*Q. virginiana* var. *maritima*). The third microhabitat is the interdunal areas, which contain sedges (*Cyperus sp*.), rushes (*Juncus scirpoides*), and salt grass (*Distichlis spicata)*.

Beach mice are restricted to the coastal barrier sand dunes along the Gulf. Optimal overall beach mouse habitat is currently thought to be comprised of a heterogeneous mix of interconnected habitats including frontal dunes, scrub (tertiary) dunes farther inland, and interdunal areas between these dune habitats, as discussed above. Beach mice dig burrows mainly in the frontal dunes and interior scrub dunes where the vegetation provides suitable cover. Most beach mouse surveys conducted prior to the mid-1990's were in primary and secondary frontal dunes because the investigators assumed that these habitats are the preferred habitat of beach mice. A limited number of surveys in scrub dunes and other interior habitat resulted in less knowledge of the distribution and relative abundance there. In coastal environments, the terms "scrub" and "scrub dune" refer to habitat or vegetation communities adjacent to and landward of primary and secondary dune types where scrub oaks are visually dominant. Interior habitat can include vegetation types such as grass-like forbs (forbs are the herbs other than grasses). There is substantial variation in scrub oak density and cover within and among scrub dunes throughout ranges of beach mice. The variation, an ecological gradient, is represented by scrub oak woodland with a relatively closed canopy at one end of a continuum. At the other extreme of the gradient, scrub dunes are relatively open with patchy scrub ridges and intervening swales or interdunal flats dominated by herbaceous plants.

Beach mice feed nocturnally in the dunes and remain in burrows during the day. Their diets vary seasonally but consist mainly of seeds, fruits, and insects (Ehrhart, 1978; Moyers, 1996). Changes in the availability of foods result in changes in diets between seasons and account for variability of seasonal diets between years. Autumn diets of beach mice consist primarily of seeds and fruits of sea oats, evening primrose (*Oenothera humifusa*), bluestem (*Schizachyrium maritimum*), and dune spurge (*Chamaesyce ammannioides*). Sea oats and beach pea (Galactia sp.) dominate winter diets. Spring diets primarily consist of dune toadflax (*Linaria floridana*), yaupon holly (*Ilex vomitoria)*, seashore elder (*Iva imbricata*), and greenbrier (*Smilax sp.*). Summer diets are dominated by evening primrose, insects, dune toadflax, and ground cherry (*Physalis augustifolia*) (Moyers, 1996). Management practices designed to promote recovery of dune habitat, increase food sources, and enhance habitat heterogeneity may aid in the recovery of beach mouse populations.

In wild populations, beach mice have an average life span of about 9 months. Males and females reach adulthood and are able to reproduce at approximately 35 days of age. Females can nurse one litter while pregnant with another litter. From captive colonies we know that litter size is 1-8 with an average of four. Young are weaned in 2-3 weeks and are generally on their own 1-2 weeks later.

Hurricanes are a natural environmental phenomenon affecting the Gulf Coast, and beach mice have evolved and persisted in coastal dune habitats since the Pleistocene. Hurricanes are part of a repeated cycle of destruction, alteration, and recovery of dune habitat. The extensive coastal dune habitat that existed along the Gulf Coast before the fairly recent commercial and residential development allowed beach mice to survive even the most severe hurricane events to repopulate dune habitat as it recovered. Beach mice are affected by the passage of hurricanes along the northwest Florida and Alabama Gulf Coast. Since records on hurricane intensity began in 1885, over 30 hurricanes have struck northwest Florida within the historic ranges of the four Gulf Coast beach mouse subspecies (Williams and Duedall, 1997; Doering et al., 1994; Neumann et al., 1993). In addition, 22 hurricanes have made landfall along the coast of Alabama from 1851 to 2004 (USDOC, NOAA, National Hurricane Center, 2006).

Hurricanes generally produce damaging winds, storm tides and surges, and rain that erode barrier-island, peninsular, and mainland beaches and dunes. Hurricanes cause increased fragmentation of habitat, which is correlated with increased distance between fragments that must be crossed by beach mice at night if they are to move between habitat patches. Gap distance travelled may decrease when visibility is poor during the new moon, making predators harder to see (Wilkinson et al., 2009). Gap distance travelled may increase if beach mice know in advance that the target patch is environmentally more favorable, making risk of predation worthwhile (Wilkinson et al., 2009). Following hurricanes, the dune system begins a slow natural repair process that may take 3-20 years, depending on the magnitude of dune loss (Salmon et al., 1982). During this period, sea oats and pioneer dune vegetation become established, collecting sand and building dunes. As the dunes grow and become stable, other successional dune vegetation colonizes the area (Gibson and Looney, 1994), and beach mouse food sources and habitats are reestablished. The rate of recovery of food supplies for beach mice is variable, with some areas adversely affected for an extended period of time by hurricane and post-hurricane conditions. Beach mice consume seeds and pass them in their feces, promoting colonization of bare areas of vegetation.

Tropical storms periodically devastate Gulf Coast sand dune communities, dramatically altering or destroying habitat, and either drowning beach mice or forcing them to concentrate on high scrub dunes where they are exposed to predators. How a hurricane affects beach mice depends primarily on its characteristics (winds, storm surge, rainfall), the time of year (midsummer is the worst), where the eye crosses land (side of hurricane—clockwise or counterclockwise), population size, and storm impacts to habitat and food sources. The interior dunes and related access corridors may be essential habitats for beach mice following survival of a hurricane. The Primary Constituent Elements that are known to require special management considerations or protection are as follows: (1) a continuous mosaic of primary, secondary, and scrub vegetation and dune structure, with a balanced level of competition, and predation and few or no competitive or predacious nonnative species present, that collectively provide foraging opportunities, cover, and burrow sites; (2) primary and secondary dunes, generally dominated by sea oats that, despite occasional temporary impacts and reconfiguration from tropical storms and hurricanes, provide abundant food resources, burrow sites, and protection from predators; (3) scrub dunes, generally dominated by scrub oaks, that provide food resources and burrow sites and that provide elevated refugia during and after intense flooding due to rainfall and/or hurricane-induced storm surge; and (4) unobstructed habitat connections that facilitate genetic exchange, dispersal, natural exploratory movements, and recolonization of locally extirpated areas; and (5) a natural light regime within the coastal dune ecosystem, compatible with the nocturnal activity of beach mice, which is necessary for normal behavior, growth, and viability of all life stages (USDOI, FWS, 2010f). Such special management considerations or protection include: management of nonnative predators and competitors, management of nonnative plants, and protection of beach mice and their habitat from threats by road construction, urban and commercial development, heavy machinery, and recreational activities (USDOI, FWS, 2006b and 2007b). Beach mice have existed in an environment subject to recurring hurricanes, but tropical storms and hurricanes are now considered to be a primary factor in the beach mouse's decline. It is only within the last 20-30 years that the combination of habitat loss due to beachfront development, isolation of remaining beach mouse habitat areas and populations, and destruction of remaining habitat by hurricanes have increased the threat of extinction of several subspecies of beach mice.

The FWS reported considerable damage to 10 national wildlife refuges in Alabama, Mississippi, Louisiana, and the Panhandle of Florida caused by Hurricane Ivan in 2004 (USDOI, FWS, 2004a). Perdido Key, Florida, was hit hard by Hurricane Ivan, and beach mouse dune habitat and populations were greatly reduced. The mice take refuge on higher ground during severe storms. Hurricane Ivan adversely impacted an estimated 90-95 percent of primary and secondary dune habitat throughout the range of the Alabama beach mouse (USDOI, FWS, 2004b). Trapping data indicate that mice may have become locally extinct in these low-lying areas (USDOI, FWS, 2004b). Approximately 3,460 ha (1,400 ac) of higher elevation scrub habitat did not appear to be inundated by storm surge from either Hurricanes Ivan or Katrina (U.S. Dept. of the Army, COE, 2002b; USDOI, FWS, 2004b, 2004c, and 2005; ENSR Corporation, 2004) but received moderate damage from salt spray and wind (Boyd et al., 2003; USDOI, FWS, 2004a). The worst damage from Hurricane Ivan occurred in Alabama to Bon Secour National Wildlife Refuge located west of Gulf Shores, Alabama, along the Fort Morgan Peninsula. Major primary dunes at Bon Secour were almost completely destroyed and tons of debris washed up on the refuge.

Following Hurricane Opal in 1995, Swilling et al. (1998) reported higher Alabama beach mouse densities in the scrub than the foredunes nearly 1 year after the storm. As vegetation began to recover, however, the primary and secondary dunes were reoccupied by Alabama beach mice, and population densities surpassed those in the scrub in the fall and winter following the storm. Similar movement and habitat occupation patterns were observed following Hurricane Georges in 1998. Therefore, while Alabama beach mouse numbers and habitat quality in the frontal dunes ebb and flow in response to tropical storms, the higher elevation scrub habitat is important to mouse conservation as a more stable environment during and after storm events.

In a population genetics study of the Alabama beach mouse, adult males were often trapped with adult females, probably their mates in this monogamous species (Tenaglia et al., 2007). These pairs were more distantly related than expected, probably because kin recognition allowed selection of unrelated mates to avoid inbreeding depression as a result of breeding of related individuals. Inbreeding depression is an increase in the frequency of harmful homozygous recessive genes, which cause reduced fitness of a population. As population levels have declined, inbreeding avoidance has become important to this subspecies. Subadults were often captured with related mice, suggesting that mice form sibling and adult-subadult familial bonds before final adult dispersal, which itself is a short distance (Tenaglia et al., 2007). Consequences for inbreeding impacts remain to be investigated.

The DWH event has so far had no recorded environmental changes for the Alabama beach mouse and probably no ecological changes yet for the other three subspecies (Leblanc, official communication, 2010). Assessment of the efficacy of shoreline cleanup in supratidal Alabama beach mouse habitat showed 60 percent "no oil observed," 37 percent "light-very light oiling," and 3 percent "moderate-heavy oiling" (OSAT-2, 2011b). Much of the supratidal habitat of Perdido Key beach mouse and Choctawhatchee beach mouse showed "no oil observed" (OSAT-2, 2011b). Supratidal habitat of St. Andrew beach mouse was not affected by the DWH event (OSAT-2, 2011b). A "toxicity reference value" is developed by USEPA for low (2-3 ring) and high (4-7 ring) molecular weight PAH's. Two scenarios for PAH's oral uptake by Alabama beach mouse were reported: 10 percent contribution and a worst-case 100 percent contribution of small surface residue balls to the overall ingestion of soil. The estimated daily dose of PAH's from oral uptake following the DWH event did not exceed the toxicity reference value for low molecular weight PAH's in the Alabama beach mouse (OSAT-2, 2011b).

No changes have been identified on the two subspecies of beach mice on the Atlantic Coast of Florida. No oil has yet been reported as entering the Loop Current to reach the east coast of Florida. A peer-reviewed computer model from NOAA predicted that a probability of shoreline threat from the DWH event to northeast Florida, including the Anastasia Island beach mouse (listed as endangered) and the southeastern beach mouse (listed as threatened), would be only 1-20 percent (USDOC, NOAA, 2010w). Any shoreline impacts would be in the form of scattered tarballs and not a large surface slick of oil. The model showed results 120 days after the spill began and assumed a 33,000-bbl/day release of oil for 90 days (USDOC, NOAA, 2010w). Vehicular traffic and activity associated with the DWH event cleanup could have trampled or buried nests and burrows or caused displacement from preferred habitat. Because of lack of thorough training of all personnel, vehicle and foot traffic that may have taken place during shoreline cleanup resulting from the DWH event could have disturbed beach mouse populations or degraded or destroyed habitat.

A study has begun that, in part, is investigating events where bulldozers in Florida allegedly breached possible beach mouse dune habitat so cleanup vehicles could reach oiled beaches (Frater, official communication, 2010 and 2011b). According to Frater (official communication, 2011c),

> No formal assessment of damage to beach mice from the MS Canyon 252 Incident has been conducted yet. No mortality to beach mice (all subspecies) from shoreline activities has been documented incidentally. However, since beach mice live in burrows, it is also unlikely that mortality would be observed in the event it occurred. Known occupied habitat has been trampled, denuded, and eroded. The amount of impacted beach mouse habitat has been assessed since the summer of 2011. Reasonable estimates of the amount of beach mouse habitat that has been damaged, altered, or destroyed varies from 1 to 50 acres throughout the range of the five Gulf Coast subspecies (four of which are federally protected). The fifth species is the Santa Rosa beach mouse. Impacts to the occupied and suitable habitat are far greater when seedlings and underground root systems are taken into account, especially along the embryonic frontal dunes; however, no attempt is being made presently to assess those damages.

Frater (official communication, 2012) states that the study of impacted beach mouse habitat has not been completed. No updated results are yet available, and any additional information is not available due to the study's role in litigation. Preliminary data suggests that impact to beach mouse habitat was very minor (Frater, official communication, 2011c). The impacts to beach mouse habitat during the DWH response probably have not caused significant impacts to the population levels of beach mice (Frater, official communication, 2011c). The habitat that was damaged was primarily young dunes; the damage may restrict population expansion and recovery for a few years, but anticipated restoration activities will probably offset this impact in the near future (Frater, official communication, 2011c).

Following the DWH event, BOEMRE requested reinitiation of ESA consultation with FWS on July 30, 2010. The FWS responded with a letter to BOEMRE on September 27, 2010. The reinitiated consultation is not complete at this time, although BOEM has developed with FWS an interim coordination program for postlease activities requiring plan approvals or permits while the formal consultation and development of a Biological Opinion remain ongoing (**Chapter 5.7**).

Beachfront development continues to be the greatest threat to beach mouse survival (Holler and Rave, 1991; Humphrey, 1992). Habitat reduction and fragmentation have affected the ability of beach mice to quickly recover following tropical storms. The combinations of habitat loss to beachfront development, isolation of remaining habitat blocks and beach mouse populations, and destruction of remaining habitat by hurricanes have increased the threat of extinction for the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice within the last 20-30 years (USDOI, FWS, 2006b and 2007b).

The BOEM acknowledges that there remains incomplete or unavailable information regarding beach mice, including information regarding the DWH event and impacts from that spill to beach mice. Nevertheless, there is scientifically credible information regarding the likelihood that beach mice were minimally impacted by oil and related tarballs from the DWH event. There is a pending study investigating the effects of DWH event cleanup activities on beach mice and their habitat. The ongoing research on potential impacts from the cleanup activities to beach mice is being conducted through the NRDA process. The NRDA research projects may be years from completion, and data and conclusions have not been released to the public. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In its place, BOEM has included what scientifically credible information is available and applied it using accepted scientific methodologies. Although information resulting from this study may be relevant to reasonably foreseeable adverse impacts on beach mice and their habitat, BOEM subject-matter experts have determined that it is not essential to a reasoned choice among alternatives. The BOEM has conservatively considered the potential for impacts from cleanup activities in the analysis below.

4.2.1.15.2. Impacts of Routine Events

Background/Introduction

This chapter discusses the possible effects of routine activities associated with a CPA proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice, which are designated as protected species under the Endangered Species Act (**Chapter 1.3**). The mice occupy restricted habitat in and behind coastal foredunes of Florida and Alabama (Ehrhart, 1978; USDOI, FWS, 1987). Portions of the beach mouse habitat have been designated as critical.

Proposed Action Analysis

The major impact-producing factors associated with routine activities of a CPA proposed action that may affect beach mice include beach trash and debris, and efforts undertaken for the removal of marine debris or for beach restoration. Beach mice may consume trash and debris. Mice may become entangled in the debris. A CPA proposed action is expected to contribute negligible marine debris or disruption to beach mice areas. Their burrows are about 1-3 m (3-10 ft) long and involve a plugged escape tunnel, which would function if the main burrow entrance was trampled by foot traffic of insufficiently trained debris cleanup personnel (beach mice would dig themselves out through the plug) (Mitchell, official communication, 2010). No impacts of coastal and nearshore OCS support activities on beach mice are expected for the following reasons: beach mouse critical habitat is protected from pipeline landfalls, terminals, and other onshore OCS-related construction; any coastal discharges into the water would not affect beach mice, which rely on fresh rather than saline drinking water; boat traffic would have no impact on beach mouse habitat, which is above high tide; and helicopter traffic is expected to occur only well to the west of beach mouse habitat.

Summary and Conclusion

An impact from the routine activities associated with a CPA proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. Impact may result from consumption of or entanglement in beach trash and debris. Because a proposed action would deposit only a small portion of the total debris that would reach the habitat, the impacts would be minimal. The BSEE prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.300; see also NTL 2012-BSEE-G01 "Marine Trash and Debris Awareness and Elimination"). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters. Unless all personnel are adequately trained, efforts undertaken for the removal of marine debris may temporarily scare away beach mice or destroy their food resources such as sea oats. However, their burrows are about 1-3 m (3-10 ft) long and involve a plugged escape tunnel, which would function after the main burrow entrance was trampled by foot traffic of insufficiently trained debris cleanup personnel.

4.2.1.15.3. Impacts of Accidental Events

This chapter discusses the possible effects of accidental events associated with a CPA proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice, which are designated as protected species under the Endangered Species Act. The major impact-producing factors resulting from accidental events associated with a CPA proposed action that may affect beach mice include offshore and coastal oil spills, and spill-response activities.

Direct contact with spilled oil can cause contact dermatitis. Fur will mat and therefore lose its insulation against heat and cold. Other direct toxic effects may result from oil ingestion or asphyxiation or from inhalation of fumes. Indirect effects may include contamination and depletion of food supply, destruction of habitat, and fouling of burrows.

The oiling of beach mice could result in local extinction, but this is very unlikely, given that the chance of a spill occurring and contacting the habitat is mostly <0.5 percent after 10 or 30 days of a spill (**Figure 3-11**), and the area of viable habitat is broad relative to the area potentially contacted by a large spill.

For a CPA proposed action, the probabilities remain low (mostly <0.5%; 1% for Perdido Key and Choctawhatchee beach mice after 30 days of a spill) (**Figure 3-11**) that an offshore spills ≥1,000 bbl would occur and contact the shoreline inhabited by the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice during the 40-year life of a CPA proposed action. Probabilities for the unlisted Santa Rosa beach mouse are similar to those of listed species (<0.5%) (**Figure 3-11**). Similarly, probabilities for the listed southeastern beach mouse and Anastasia Island beach mouse on the east coast of Florida are always <0.5 percent (**Figure 3-11**). Spills in coastal waters could occur at storage or processing facilities and at service bases supporting a proposed action; however, these facilities would not likely be located near beach mouse habitat.

Recovery of habitat from hurricanes involves a vital link between mouse food supply (involving seeds of dune-stabilizing vegetation) and habitat. The seeds are spread in mouse feces so vegetation will colonize bare areas created by hurricanes. The link is not unique to the beach mouse (it may occur in many habitats) and may be lost after an oil spill; this loss may result in extinction of the beach mouse after later serious storms or hurricanes or further beachfront development disrupts habitat. Impacts can also occur from spill-response activities. Vehicular traffic and other activities associated with oil-spill cleanup can degrade preferred habitat and cause displacement of mice from these areas without thorough training of all personnel, which in an emergency would need to happen on short notice.

There is no definitive information on the persistence of oil in the event that a spill was to contact beach mouse habitat. In Prince William Sound, Alaska, after the *Exxon Valdez* spill in 1989, buried oil has been measured in the intertidal zone of beaches, but no effort has been made to search for residual buried oil above high tide. Similarly, NRC (2003) makes no mention of studies of oil left above high tide after a spill. Regardless of the potential for persistence of oil in beach mouse habitat, a slick cannot wash over the foredunes unless carried by a heavy storm swell.

Summary and Conclusion

The oiling of beach mice could result in local extinction. Oil-spill-response and cleanup activities could also have a substantial impact to the beach mice and their habitat if all cleanup personnel are not adequately trained. However, potential spills that could result from a CPA proposed action are not expected to contact beach mice or their habitats. The probability of contact with the shoreline next to beach mouse habitat is unlikely (mostly <0.5% probability; **Figure 3-11**), and the probability of oil washing over the foredunes to beach mouse habitat is even less. Also, inshore facilities related to a CPA proposed action are unlikely to be located on beach mouse habitat.

Within the last 20-30 years, the combination of habitat loss due to beachfront development, isolation of remaining beach mouse habitat areas and populations, and destruction of remaining habitat by tropical storms and hurricanes has increased the threat of extinction of several subspecies of beach mice. Destruction of the remaining habitat due to a catastrophic spill and cleanup activities would increase the threat of extinction, but the potential for a catastrophic spill that would substantially affect beach mice habitat is low.

A review of the available information shows that impacts on beach mice from accidental impacts associated with a CPA proposed action would be minimal.

4.2.1.15.4. Cumulative Impacts

This chapter discusses the possible cumulative effects of all activities in the study area (past, present, and reasonably foreseeable), along with the effects of a CPA proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice, which are designated as protected species under the Endangered Species Act. Cumulative effects have a potential to harm or reduce the numbers of beach mice. The major impact-producing factors that affect beach mice include oil spills, alteration and reduction of habitat, predation (especially from domestic cats) and competition, consumption of and entanglement in beach trash and debris, beach development, coastal spills, and natural catastrophes (i.e., hurricanes and tropical storms). Most proposed action-related spills, as well as oil spills stemming from import tankering and prior and future lease sales, are not expected to contact beach mice or their habitats. Cumulative impacts could potentially deplete some beach mice populations to unsustainable levels. The expected incremental contribution of a CPA proposed action to the cumulative impacts is negligible.

The results of a baseline Population and Habitat Viability Analysis (PHVA) model of the Alabama beach mouse (Traylor-Holzer et al., 2005) suggest that the Alabama beach mouse metapopulation has an 18-21 percent probability of extinction over 100 years, depending on whether the habitat recovers slowly or quickly following hurricanes. Sensitivity tests for the model give probabilities of extinction of 13-36 percent over 100 years. Habitat restoration reduces the probability of Alabama beach mouse extinction at or immediately following a hurricane. Recolonization by translocation could reduce the possibility of Alabama beach mouse extinction. A relatively small number of domestic cats would result in virtually certain extinction of the Alabama beach mouse. Development scenarios have, at most, minor impacts on the estimates of probabilities of Alabama beach mouse extinction.

Many of the model parameters were uncertain and may have been inaccurate, resulting in uncertainty in the probability of Alabama beach mouse extinction. Revision of the model using data collected after Hurricane Ivan (Traylor-Holzer, 2005) projects a 14 percent risk of extinction over the next 100 years. Much of the risk is from hurricanes. None of the revised development scenarios result in certain Alabama beach mouse extinction. The highest risk from development is a 34 percent chance of extinction over 100 years. Under the revised model, habitat restoration efforts are unlikely to substantially reduce or eliminate extinction risk. Data collected after Hurricane Katrina were used in a second revision of the model (Reed and Traylor-Holzer, 2006). The revised model projects a risk of extinction of 26.8 ± 1.0 percent over the next 100 years. Destruction of migration corridors between populations raises the risk to 41.2 ± 1.1 percent, but only 34.9 ± 1.1 percent with the translocation of mice. Total loss of private land as suitable habitat raises the risk further to 46.8 ± 1.1 percent, but only 40.8 ± 1.1 percent with the translocation of mice.

Population Viability Analyses are complex simulation models with untested predictions. Hanski (1999, pp. 203-204) states, " . . . my preference is for relatively simple models such as the incidence function model rather than for complex models, especially when the habitat is highly fragmented. Insight from relatively simple and general metapopulation models are likely to be more helpful for managers than uncertain predictions based on untested complex models." The incidence function model is described in detail in Hanski (1999, pp. 233-261).

Due to the extended distance of most OCS activities from shore, the incremental impacts associated with a CPA proposed action are not expected to impact beach mice when compared with the cumulative effects of non-OCS Program factors.

Summary and Conclusion

Cumulative activities have the potential to harm or reduce the numbers of Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice. Those activities include oil spills, alteration and reduction of habitat, predation and competition, consumption of and entanglement in beach trash and debris, beach development, and natural catastrophes (hurricanes and tropical storms). Most spills related to a CPA proposed action and prior and future lease sales are not expected to contact beach mice or their habitats because the species lives above the intertidal zone where contact is less likely. Cumulative impacts could potentially deplete some beach mice populations to unsustainable levels. Impacts from OCS activities could come from trash and debris and effort to remove them, as well as oil spills and cleanup operations. If personnel are properly trained (on short notice if under emergency conditions) and supervised, these impacts could be reduced. The expected incremental contribution of a CPA proposed action to the cumulative impacts is negligible.

4.2.1.16. Coastal and Marine Birds

The BOEM's analysis for coastal and marine birds is based on the best available and latest information and in consideration of the DWH event. A brief summary of potential impacts follows, with full analyses found in the respective sections below.

Routine Activities: Impacts to avian species are expected to be adverse, but not significant, and may include

- behavioral effects;
- exposure to or intake of OCS-related contaminants and discarded debris;
- disturbance-related impacts; and
- displacement of birds from habitats that are destroyed, altered, or fragmented, making these areas otherwise unavailable.

Accidental Events (Oil Spills and Spill Cleanup): Impacts to avian species could be significant and may include

- mortality as well as sublethal, chronic short- and long-term effects; and
- impacts to food resources.

Cumulative Activities: The incremental impact from a CPA proposed action to avian species is expected to be adverse, but not significant, and may include

- discernible changes to avian species' composition, distribution, and abundance; and
- may cause further reductions in the overall capacity of the habitat to sustain current population levels of some species due to habitat loss, alteration, or fragmentation.

4.2.1.16.1. Description of the Affected Environment

The following information is a summary description of the coastal and marine birds. An extensive search of Internet bibliographic databases was conducted to determine the availability of recent information. New information (Oil Spill Commission, 2011b; USDOI, FWS, 2010f) has been identified that may alter the impact conclusion for coastal and marine birds since previous NEPA documents were completed and in light of the DWH event.

Area Classifications

The Gulf of Mexico OCS and adjacent lands encompass three distinct land-base Bird Conservation Regions (BCR's) and two Pelagic BCR's (74 and 77) identified by the North American Bird Conservation Initiative (2000), and more recently updated by FWS (USDOI, FWS, 2008a) (**Figure 4-11**); see also Kushlan et al. (2002) and Hunter et al. (2006). The land-based BCR's in the Gulf of Mexico include BCR 27 (Southeastern Coastal Plain), BCR 31 (Peninsular Florida), and BCR 37 (Gulf Coast Prairie) (**Tables 4-9, 4-10, and 4-11**). The BCR's 27 and 31 are exclusively contained within the EPA, whereas BCR 37 extends from the western boundary of the EPA through the CPA and into the WPA. Within each BCR, the Fish and Wildlife Service has identified Birds of Conservation Concern. For purposes of this EIS, the Bureau of Ocean Energy Management has further separated these species into three broad categories: species with the potential to be impacted by offshore oil and gas development; species with a high probability of oiling in the event of a spill; and other species, as well as columns reflecting whether the species is considered a breeder or nonbreeder and its associated habitat (**Tables 4-9, 4-10, and 4-11**; USDOI, FWS, 2010e). The estimates provided below are based on published scientific methodologies and available DWH event data for birds (USDOI, FWS, 2010e; King and Sanger, 1979; Williams et al., 1995; Camphuysen, 2006).

For the CPA, all three BCR's are considered. Bird Conservation Region 27 (**Table 4-9**) includes 53 Birds of Conservation Concern, of which 30 (56.6%) may be considered as having the potential to be impacted by offshore oil and gas development, with 21 (39.6%) representing species with a high probability of oiling in the event of a spill. Bird Conservation Region 31 (**Table 4-10**) includes 49 Birds of Conservation Concern, of which 30 (61.2%) may be considered as having the potential to be impacted by offshore oil and gas development, with 21 (42.9%) representing species with a high probability of oiling in the event of a spill. Bird Conservation Region 37 (**Table 4-11**) includes 44 Birds of Conservation Concern, of which 30 (68.2%) may be considered as having the potential to be impacted by offshore oil and gas development, with 20 (45.4%) representing species with a high probability of oiling in the event of a spill. In general, the potential to be impacted by offshore oil and gas development was based on a species' life-history strategy, its habitat use and preference, its distribution and abundance, as well as its behavior relative to the breeding season, overwinter period, or during staging. It should also be noted that the Gulf of Mexico includes National Wildlife Refuges. Refuges with a marine component in Alabama (n = 1; 7,152 ac [2,894 ha]), Florida (n = 19; 758,997 ac [307,155 ha]), Louisiana (n = 7; 250,070 ac [101,200 ha]), and Mississippi (n = 2; 27,470 ac [11,117 ha]) and are managed primarily for the protection and conservation of migratory birds (**Figure 4-12**). Additional important bird areas within the Gulf of Mexico have been identified by the National Audubon Society, Inc. (2010) and American Bird Conservancy (2010) (**Figures 4-13 and 4-14**, respectively).

Nonendangered and Nonthreatened Species

The Gulf of Mexico is populated by both resident breeding and nonbreeding migratory species of coastal and marine birds (Parnell et al., 1988; Visser and Peterson, 1994; Mikuska et al., 1998). Estimates of the number of breeding and nonbreeding migratory species (values in parentheses represent number of breeding and wintering species, respectively) by states (1950-2011) are as follows: Alabama (209, 389); Florida (331, 554); Louisiana (251, 434); and Mississippi (207, 358). The breeding period was defined as occurring in June-July, whereas the wintering period included all other months.

Herein, the more common coastal and marine species are separated into seven generic groups: diving birds; seabirds; shorebirds; passerines (songbirds); marsh and wading birds; waterfowl; and raptors.

Some species (seabirds) are relegated to primarily the pelagic (offshore) environment (e.g., northern gannet; Audubon's, Cory's, and greater shearwater) and, therefore, are rarely observed in the nearshore environment. The remaining species are found within coastal and inshore habitats and may be more susceptible to potential deleterious effects resulting from OCS-related activities because many of these species largely overlap spatially and temporally with OCS activities, due to their abundance or density, and the potential of oil impacting their habitat or food resources (Clapp et al., 1982 and 1983). Previous surveys indicate that Louisiana and Texas (and Florida) are among the primary states in the southern and southeastern U.S. for both nesting colonies and total number of breeding coastal and marine birds (Portnoy, 1978 and 1981; Hunter et al., 2006). All avian species show varying levels of fidelity to both breeding and wintering areas; therefore, discussions of available, unaltered habitat should be kept in context. Without a thorough understanding of species' habitat use and preferences, a species' ability to locate and colonize alternative habitat, and the population structure (i.e., metapopulation theory [Esler, 2000]), it is difficult to make inferences regarding the ability of individual birds or groups to successfully emigrate and colonize novel, undisturbed habitat (assuming it is available) (Fahrig 1997, 1998, and 2001). **Tables 4-9 through 4-11** provide information on the various representative species, their breeding status, and general habitat. Although this information may be relevant to reasonably foreseeable adverse impacts on birds, it would also be difficult to discern effects from other factors, and it is not within BOEM's ability to obtain this information across species and vast habitat areas in the timeline of this EIS and without exorbitant costs. The BOEM subject-matter experts, however, feel this information is not essential to a reasoned choice among alternatives, including the No Action alternative. The BOEM subject-matter experts have included what scientifically credible information is available, applied using accepted scientific methodologies. In addition, BOEM has conservatively assumed that birds may not be able to relocate to suitable replacement habitat, and as described below, impacts would still not be expected to be significant, with the possible exception of a low-probability catastrophic event.

Diving Birds

There are four main groups of diving birds: Phalacrocoracidae (cormorants, 2 representative species); Anhingidae (anhingas, 1 species); Gaviidae (loons, 2 species); and Podicipedidae (grebes, 5 species). The only representative diving birds known to breed in waters of the Gulf are the double-crested and olivaceous/neotropic cormorants, with the other representatives occurring primarily in near- and offshore waters during the winter period or breeding in more inland freshwater habitats. Loons and grebes frequently spend most of their diurnal and nocturnal activity budgets resting, loafing, and conducting other maintenance activities on the water, swimming as a primary means of locomotion, as well as diving for food; they are particularly vulnerable to oil spills in coastal waters (King and Sanger, 1979).

Five species of diving birds are known to have been impacted by the DWH event (**Table 4-8**) and are listed below:

- common loon (75 collected, 39 visibly oiled, 52% oiling rate);
- double-crested cormorant (23 collected, 2 visibly oiled, 9% oiling rate);
- neotropic cormorant (5 collected, 0 oiled);
- great cormorant (1 collected, 0 oiled); and
- pied-billed grebe (32 collected, 24 visibly oiled, 75% oiling rate).

Values for oiling rates throughout this EIS represent percentages (value x 100 = actual %). Diving birds had the third highest oiling rate (27 ± 15%) of the seven species' groups considered (**Table 4-12**). Effects of the DWH event are discussed in more detail below. The FWS has not indicated to date whether it will be performing necropsies on some or all of the birds collected after the DWH event. The BOEM has conservatively assumed that all birds collected may have been as a result of the DWH event (although the final causes of deaths have not been conclusively determined) and notes that these numbers tend to underestimate the total number of birds that may have died as a result of the event. With the exception of federally listed birds described below, BOEM subject-matter experts do not believe that most species of birds had population impacts related to the DWH event, although data remain incomplete at this time

Seabirds

There are nine main groups of seabirds that spend the majority of their life-history cycle in a saltwater environment, often far offshore in the waters of the northern Gulf of Mexico: Diomedeidae (albatrosses; 1 or 2 species = accidental); Procellariidae (petrels and shearwaters; several species); Hydrobatidae (storm-petrels; several species); Fregatidae (frigatebirds; magnificent only); Phaethontidae (tropicbirds; white-tailed most common); Pelecanidae (pelicans; brown and white); Sulidae (gannets and boobies;

northern gannet and masked booby most common); Laridae (skuas, jaegers, gulls, and terns; numerous representatives); and Scolopacidae (phalaropes; Wilson's and red-necked) (Duncan and Havard, 1980). In the Gulf, this species group includes both breeders and nonbreeders, with some of the breeders considered year-round residents. The area includes two Pelagic BCR's (74 and 77). For additional information on the two Pelagic BCR's in the Gulf of Mexico, and the associated priority seabird species, refer to Kushlan et al. (2002) and Hunter et al. (2006).

One of the more iconic of the seabird species in the Gulf of Mexico is the eastern brown pelican. It is discussed separately in the threatened and endangered section below.

Colonies of laughing gulls, eight species of terns, and black skimmers nest in the Gulf (Martin and Lester, 1991; Visser and Peterson, 1994). Seabirds are generally considered as colonial nesters with the degree of colony formation and density varying among species. In general, seabirds tend to occur at low densities over much of the ocean and are patchily distributed with relatively higher densities occurring at *Sargassum* lines, upwellings, convergence zones, thermal fronts, salinity gradients, and areas of high planktonic productivity (Ribic et al., 1997; Davis et al., 2000). Also, platforms represent profitable foraging areas for seabirds (Wiese et al., 2001). Species assemblages and densities tend to occur as zones related to distance from shore. The nearshore zone tends to be dominated by a Larids-Sternids-Eastern brown pelican complex, and the area off the shelf-break is dominated by Procellarids-Hydrobatids-magnificent frigatebirds-jaegers-Phaethontids (Duncan and Havard, 1980). However, there remains variation in seabird communities, and birds considered rare or infrequently documented may simply reflect a lack of survey effort.

Seabirds obtain their food through a variety of behaviors and foraging strategies including kleptoparasitism, scavenging, dipping, plunge-diving, and surface feeding. Nesting terns include Caspian (*Sterna caspia)*, royal (*S. maxima*), sandwich (*S. sandvicensis*), common (*S. hirundo*), Forster's (*S. forsteri*), coastal least (*S. antillarum*), gull-billed (*Sterna nilotica*), and sooty (*S. fuscata*). All of the terns nesting in the Gulf of Mexico, as well as the Arctic tern (*S. paradisaea*), bridled tern (*S. anaethetus*), black tern (*Chlidonias niger*), brown noddy (*Anous stolidus*), and black noddy (*Anous minutus*), may be found in waters of the Gulf. Most of these species forage exclusively on small fish and feed by plunge-diving, often from a hovering position. Terns, gannets and boobies (*Sula* spp.) as well, are streamlined for plunge-diving and the underwater pursuit of fish. All seabirds are colonial nesters and all evolved from colonial land birds. A discussion of coloniality in seabirds is relevant to their increased potential vulnerability to anthropogenic disturbance (Carney and Sydeman 1999; Rojek et al., 2007) and habitat loss (Buckley and Buckley, 1980; Goss-Custard et al., 1995a and 2006).

Seabirds (and some representatives of diving birds and shorebirds) are relatively long-lived avian species with delayed maturity, low reproductive potential, periodic nonbreeding, low first-year survival, and small clutch size (Dunnet, 1982). Populations appear to be most sensitive (population growth rate [λ] = 1 for "stable" population) to changes (even small decreases) in adult survival, particularly female survival because adult female survival appears to be the driver for these populations (Russell, 1999, Table 1; **Figures 4-18 and 4-19**). Also, for some species like the northern gannet, a large segment of the population is comprised of nonbreeding age individuals. These individuals do not have the capacity to affect population-level reproductive potential until they attain sexual maturity. Mortality after the first year for most of the seabird species is likely additive given what we know about species' demography (Ford et al., 1982; Croxall and Rothery, 1991). In his review, Russell (1999) used a simplified life-cycle model to estimate population growth rates (λ) under ideal conditions for a number of seabird species, but he appropriately cautioned that realized population growth rates in nature would always be lower.

Table 4-13 includes information on avian life history and demography. A discussion of avian demography and population recovery potential is also addressed in the DWH baseline conditions section below.

In summary, however, it appears that 26 species of seabirds were impacted by the DWH event; a complete list can be found in **Table 4-8**. The five bird seabird species most impacted (based on number collected) by the DWH event were all seabirds, and representative species are listed below:

- laughing gull (2,981 collected, 1,182 visibly oiled, 40% oiling rate);
- brown pelican (826 collected, 339 visibly oiled, 41% oiling rate);
- northern gannet (475 collected, 297 visibly oiled, 63% oiling rate);

- royal tern (289 collected, 149 visibly oiled, 52% oiling rate); and
- black skimmer (253 collected, 55 visibly oiled, 22% oiling rate).

Seabirds had the highest oiling rate (34 ± 5%) of the seven species' groups considered (**Table 4-12**). Overall, the mean oiling rate (43%) for the five species of seabirds mentioned above was well above that of the combined oiling rate (24%) of all birds collected (including "unknowns" and "other"). Of the federally listed avian species, the least tern appeared to be the most likely to have been severely impacted from the DWH event (106 collected, 49 visibly oiled, 46% oiling rate) (**Table 4-8**); but it is believed that least terns collected post-DWH were from the nonlisted coastal breeding population, as the Interior population was not present near the coast at the time of the DWH event and aftermath. Effects of the DWH event are addressed in more detail below.

Shorebirds

Shorebirds are members of the order Charadriiformes and are generally restricted to coastal habitat (e.g., beaches, dunes, islands, points, lagoons, and peninsulas), brackish marsh (coastal marsh edges and mudflats exposed at low tide), and freshwater marsh habitat (exposed mudflats and shorelines). The Gulf of Mexico shorebirds comprise five taxonomic families: Jacanidae (jacanas; *N. jacana*), Haematopodidae (oystercatchers; American and black oystercatcher), Recurvirostridae (stilts and avocets; black-necked stilt, American avocet), Charadriidae (plovers; 7-8 representatives), and Scolopacidae (sandpipers, snipe, and allies; too numerous to list). Most of the shorebirds are solitary nesters, and the majority of the sandpipers are winter residents. Along the central Gulf Coast, ≥39 species of shorebirds have been recorded (Withers, 2002). However, of these, only 6-8 species are known breeders in the area; the remaining 31-33 species are considered winter residents and/or staging migrants (Clapp et al., 1983; Withers, 2002).

The Gulf Coast represents some of the most important shorebird habitat in North America (Withers, 2002, Figure 10), particularly the Laguna Madre ecosystem along the south Texas coast. Wintering shorebirds are likely more abundant in the WPA compared with the CPA largely due to the unvegetated coastal wetland habitats (e.g., beaches, bays, inlets, lagoons, and tidal flats; Texas, southwestern Louisiana) in the former area (Withers, 2002). Shorebird species of conservation concern in the northern Gulf of Mexico include the piping plover, snowy plover, mountain plover, Wilson's plover, American oystercatcher, red knot, buff-breasted sandpiper, whimbrel, long-billed curlew, Hudsonian godwit, solitary sandpiper, upland sandpiper, semi-palmated sandpiper, western sandpiper, lesser yellowlegs, dunlin, short-billed dowitcher, and marbled godwit (Brown et al., 2001; Hunter et al., 2002). Many transients including most sandpipers nest in Arctic Canada and Alaska, with some species of grassland-nesting shorebirds found primarily in the Prairie Pothole Region of the U.S. and Canada. An important characteristic of almost all shorebird species is their strongly developed migratory behavior. Some shorebird species migrate from breeding areas in the high Arctic tundra to the southern part of South America (Morrison, 1984; Morrison et al., 2006). Both spring and fall migrations take place in a series of stops among various staging areas. At these staging areas, birds spend time primarily feeding to recover reserves necessary for the sustained flight to the next staging area (Norris, 2005; Krapu et al., 2006; Skagen, 2006). Many coastal habitats along the Gulf of Mexico are critical for such purposes (**Figures 4-13 and 4-14**).

Changes in the Arctic may alter shorebird use in the Gulf. There is some evidence that climate change in the Arctic region is resulting in earlier snow melt. Such changes may result in food resources becoming available sooner, such that the peak of preferred food resources are now out-of-sync (temporal mismatch) with peak arrival times for some avian species (Piersma and Lindström, 2004). A more detailed discussion of the potential effects of climate change on birds is provided in the cumulative impacts section. It will be necessary for shorebirds (and other long-distance migrants) to adapt to such changes by modifying the timing of spring migration or potentially suffer reproductive consequences of this mismatch (Crick, 2004; North American Bird Conservation Initiative, 2010).

Shorebirds feed primarily on insects and a variety of marine and freshwater invertebrates, fish, and very limited amounts of vegetative material. Shorebirds using the coastal environment for feeding (or roosting) during the winter or for staging may not find sufficient food resources in other habitats, particularly if sea-level rise causes additional habitat loss (Myers, 1983; Galbraith et al., 2002). In addition, any changes to the tides that force birds to utilize other nontidal habitats may result in reduced foraging efficiency due to a combination of reduced forage availability, increased search time, increased processing time, reduced energy gain/prey item consumed, prey switching, etc. (Burger et al., 1977; Goss-Custard, 1984). Shorebirds, and specifically Calidrid sandpipers, are adapted to take advantage of tidal-influenced habitat. Their diurnal movements and habitat use appears to be closely linked to tidal advances and recessions; lunar, solar, or wind-driven tides. Shorebird morphology and behavior is adapted to capitalize on the niche provided by the coastal, tidally influenced environment. Different species of sandpipers are adapted to feed in different places on different prey with diverse feeding methods (Goss-Custard, 1980; Goss-Custard et al., 1977). Some species peck for abundant aerobic invertebrates, worms, and small crustaceans at the oxidized benthic surface, a "sewing machine" motion (Sutherland et al., 2000), which is best done with a straight bill (Nebel et al., 2005). Some probe for infaunal polychaetes in their burrows lined with oxidized sediment in the mud, which otherwise has low or no oxygen (Sutherland et al., 2000), which is best achieved with a curved bill (Nebel et al., 2005). Dunlin terminate probing and initiate pecking, possibly in response to desiccation and reduced penetration of the sediment (Kuwae et al., 2010). Some shorebirds draw-up the boundary film and its organisms from the surface of the sediment. Finally, some even use surface tension to slightly open their long thin bills drawing-up water droplets containing small organisms (Rubega and Obst, 1993; Rubega, 1997; Prakash et al., 2008).

Many of the overwintering shorebird species remain within specific areas throughout the season and exhibit among-year wintering site fidelity, at least when not disturbed by humans (Haig and Oring, 1988; Drake et al., 2001). These species may be especially susceptible to localized impacts from disturbance and oiling, resulting in habitat loss or degradation, unless they disperse to unoiled or unaltered habitats, assuming such habitats are available (Skagen and Knopf, 1994; Haig et al., 1998). Twelve species of shorebirds were impacted by the DWH event. The five shorebird species most impacted (based on number collected) by the DWH (**Table 4-8**) event are listed below:

- sanderling (26 collected, 4 visibly oiled, 15% oiling rate);
- ruddy turnstone (13 collected, 3 visibly oiled, 23% oiling rate);
- American oystercatcher (13 collected, 7 visibly oiled, 54% oiling rate);
- willet (13 collected,3 visibly oiled, 23% oiling rate); and
- semi-palmated sandpiper (3 collected, 3 visibly oiled, 100% oiling rate).

Unexpectedly, shorebirds had the second lowest oiling rate (18 ± 9%) of the seven species groups considered (**Table 4-12**). It should be noted that the oiling rate for this avian group may have been biased low due to the low probability of detection because of small body size but also due to small sample size for individual species that were oiled. Further, many representative shorebird species may simply have not been present during the DWH event, likely migrating north to the breeding areas prior to the blowout and not yet reaching the impacted area during their migration to wintering areas. Effects of the DWH event are addressed in more detail below.

Passerines

Passerines, also referred to as songbirds, are the most diverse and numerically most abundant of the seven avian species groups considered herein, even though they represent a small fraction of the Birds of Conservation Concern in BCR's 27, 31, and 37 (**Table 4-11**). Representative species of this group likely represent >75 percent of all breeding and wintering birds within the Gulf Coast States. Passerines comprised a major proportion of all birds identified by Russell (2005, Table 6.12) at offshore platforms (1998-2000). Many species of passerines migrate across the Gulf of Mexico each spring (3-week peak; April 22-May 13) and fall (~4-week period; September 25-October 15) (Russell, 2005). Russell (2005) estimated on the order of 147-316 million migrant birds crossed the Gulf of Mexico, of which, approximately 190 species were passerines. Like most other avian species (except introduced species like the European starling, house sparrow, and rock dove and nonmigratory birds, e.g., wild turkey), passerines are protected under the Migratory Bird Treaty Act. Additional information regarding species composition and distribution among coastal states in the Gulf of Mexico can be found in Fontenot and Miller (2001) and Rappole (2006).

Twenty-one species of passerines were impacted by the DWH event. The five passerine species most impacted (based on number collected) by DWH (**Table 4-8**) are listed below:

- rock dove (16 collected, 3 visibly oiled, 19% oiling rate);
- mourning dove (15 collected, 3 visibly oiled, 20% oiling rate);
- seaside sparrow (9 collected, 4 visibly oiled, 44% oiling rate);
- purple martin (5 collected, 1 visibly oiled, 20% oiling rate); and
- northern mockingbird (5 collected, 0 visibly oiled).

Not surprisingly, passerines had the third lowest oiling rate (19 ± 7%) of the seven species groups considered (**Table 4-12**). The only coastal marsh obligate species on this list and a Species of Conservation Concern is the seaside sparrow. It should be noted that the oiling rate for this avian group may have been biased high due to the small sample size for individual species that were collected and oiled. However, this bias may have been offset somewhat by the low probability of detection due to their small body size. Effects of the DWH event are addressed below..

Marsh and Wading Birds

Collectively, the following families of wading birds have representatives in the northern Gulf: Ardeidae (herons, bitterns and egrets; too numerous to list); Ciconiidae (wood storks; single representative); Threskiornithidae (ibises and spoonbills; 4 species); and Gruidae (whooping crane and sandhill crane). Seventeen species of wading birds in the Order Ciconiiformes are currently known to nest in the northern Gulf coastal region; all except the wood stork (Martin, 1991). A census of south Louisiana wading bird nesting colonies was completed in 2001 (Michot et al., 2003; see also Hunter et al., 2006). Wading birds are a group of species that have adapted to living and foraging in shallow water. They typically have long legs and necks with elongated, strong bills that are used to probe under water, to make quick spearing movements, or to filter their prey. They have varied diets (e.g., small fish, frogs, crayfish, and shrimp) depending on species, and within a species, their diet may vary geographically and seasonally. Within the central Gulf Coast region, Louisiana supports the majority of nesting wading birds in the Gulf of Mexico (Fontenot and Miller, 2001; Rappole, 2006) due to the vast coastal marshes and undeveloped barrier islands (Visser et al., 2005). Nests tend to be concentrated in freshwater riparian bottomland, hardwood forested wetlands, along rivers, in available herbaceous cover adjacent to canal systems, and on islands wherever trees and shrubs are present. Great egrets are the most widespread nesting species in the central Gulf region (Martin, 1991), while little blue herons, snowy egrets, and tricolored herons constitute the greatest number of coastal nesting pairs in the western Gulf Coast.

The term "marsh bird" is a general term for a bird that lives in or around marshes and swamps. Members of the Rallidae family (rails, including moorhens, and gallinules) are considered marsh not wading birds. Many representatives of this family (rails in particular) are elusive and rarely observed within the low, dense vegetation of fresh and saline marshes, swamps, and rice fields, where their primary means of locomotion is walking on long toes. Rails tend to escape both predators and human disturbance by running through the marsh vegetation rather than flying (Tacha and Braun, 1994).

Of the 166 species included in the *Waterbird Conservation Plan of the Americas* (Kushlan et al., 2002, Figure 4), 64 percent represent species of moderate or high concern or are considered highly imperiled. Three representatives from this group are federally listed as threatened or endangered and may occur in the CPA: whooping crane (endangered); Mississippi sandhill crane (endangered); and wood stork (endangered, but recommendation to change status to threatened) (**Table 4-14**). A more detailed treatment of threatened and endangered avian species is provided below. In addition, several other species from this group are considered state species of conservation concern or birds of conservation concern by FWS (**Tables 4-9 through 4-11**). Species of conservation concern in Alabama include least bittern, reddish egret, wood stork, and the yellow and black rail. In Florida, species include Florida sandhill crane, limpkin, little blue heron, reddish egret, roseate spoonbill, snowy egret, tricolored heron, white ibis, wood stork, and whooping crane. In Louisiana, species include yellow, black, clapper, and king rail; American bittern; reddish egret; yellow-crowned night heron; and wood stork. Mississippi species include American and least bittern; yellow, black, and king rail; little blue heron; reddish egret; snowy egret; tricolored heron; white ibis; Mississippi sandhill crane; wood stork; yellow- and black-crowned night heron; and purple gallinule. State-listed species for Texas include reddish egret, white-faced ibis, wood stork, and whooping crane. Habitat loss and degradation represent the greatest challenges to the conservation of waterbirds in the southeastern U.S. (Hunter et al., 2006). Global climate change may further exacerbate wetland habitat loss (e.g., creating deepwater habitats and vegetation loss due to saltwater intrusion) in the northern Gulf of Mexico (Erwin et al., 2006), and impacts to this avian species group could be particularly severe (Butler and Vennesland, 2000; Norris et al., 2004).

Twenty-one species of marsh and wading birds were impacted by the DWH event. The five marsh and wading bird species most impacted (based on number collected) by DWH (**Table 4-8**) are listed below:

- clapper rail (120 collected, 29 visibly oiled, 24% oiling rate);
- great blue heron (42 collected, 6 visibly oiled, 14% oiling rate);
- cattle egret (36 collected, 7 visibly oiled, 19% oiling rate);
- tri-colored heron (31 collected, 11 visibly oiled, 35% oiling rate); and
- great egret (31 collected, 7 visibly oiled, 23% oiling rate).

Overall, this group had the fourth highest oiling rate (26 ± 5%) of the seven species' groups considered (**Table 4-12**). In addition, this group had the second highest number of birds collected (n = 378) and number of birds oiled (n = 100) (**Table 4-12**). Effects of the DWH event are addressed in more detail below.

Waterfowl

Waterfowl (order Anseriformes) include representatives of swans, geese, and ducks. Thirty-three species of waterfowl are known to occur along the north-central and western Gulf Coast; primarily during the winter period. The breeding assemblage of waterfowl found in coastal marshes in the Gulf Coast States tends to be small compared with the northern breeding grounds (e.g., Prairie Pothole Region), probably consisting of five representative species of ducks and one goose (e.g., mottled duck, fulvous whistling duck, black-bellied whistling duck, wood duck, hooded merganser, and Canada goose). The winter assemblage may include the following: 1 swan (trumpeter swan); 6 geese (i.e., greater white-fronted goose, Ross' goose, lesser snow goose, Canada goose, Cackling goose, and black brant); 8 dabbling ducks (genus *Anas*; i.e., mallard, mottled duck, American wigeon, northern pintail, northern shoveler, blue-winged teal, American green-winged teal, and gadwall); 5 pochards (genus *Aythya*; canvasback, redhead, lesser scaup, greater scaup, and ring-necked duck); and 14 others (Bellrose, 1980; Baldassarre and Bolen, 1994). In addition, the cinnamon teal and masked duck are known to occur as nonbreeders in Gulf Coast States (primarily Texas, but may occur in southwest Louisiana).

Most waterfowl species migrate from wintering grounds along the Gulf Coast to summer breeding grounds in the prairies, parklands, and tundra in the north. Waterfowl migration pathways have traditionally been divided into four roughly parallel north-south "flyways" across the North American continent (Bellrose, 1980). The Gulf Coast serves as the southern terminus of both the Central (Texas is the only representative state) and Mississippi (Louisiana, Mississippi, and Alabama) Flyways. Coastal marshes of Louisiana (~3,800 mi^2; ~9,842 km^2) and Texas (~741mi^2; ~1,919 km^2) represent key wintering habitats for waterfowl; together representing ~50 percent of the coastal marshes of the U.S.; excluding Alaska (Baldassarre and Bolen, 1994). Louisiana provides wintering habitat for ~4 million ducks or about 67 percent of the Mississippi Flyway wintering population (Bellrose, 1980; Baldassarre and Bolen, 1994). Also, Louisiana is home to ~50 percent of the continental population of the nonmigratory mottled duck (Stutzenbaker, 1988). The Texas Gulf Coast is the key wintering area for waterfowl of the Central Flyway; wintering 1.3-4.5 million ducks (30-70%) and roughly 90 percent of the Flyway's goose population (Bellrose, 1980; Baldassarre and Bolen, 1994). In total, the area winters an estimated 8-10 million ducks, >500,000 geese, and 1-1.5 million American coots (Chabreck et al., 1989; Hobaugh et al., 1989). Waterfowl are highly social and possess a diverse array of feeding adaptations related to their habitat (Pöysä, 1983; Nudds, 1992). In the Gulf of Mexico, wintering waterfowl could suffer substantial losses if considerable oiling of their preferred foraging or roosting habitats occurred; primarily in coastal brackish marshes.

Twelve species of waterfowl were impacted by the DWH event. The five waterfowl species most impacted (based on number collected) by DWH (**Table 4-8**) are listed below:

- mallard (26 collected, 6 visibly oiled, 23% oiling rate);
- mottled duck (6 collected, 0 visibly oiled);
- blue-winged teal (6 collected, 0 visibly oiled);
- Canada goose (4 collected, 1 visibly oiled, 25% oiling rate);
- red-breasted merganser (2 collected, 1 visibly oiled, 50% oiling rate).

Overall, this group had the second highest oiling rate (33 ± 12%) of the seven species' groups considered (**Table 4-12**). This oiling rate is probably biased low due to the contributions of four species that had no oiling, i.e., zero contributions are "oversampled" (**Table 4-8**). Interesting was both the number (n = 26) of mallards collected and their oiling rate (23%); both values seemed high given their preferential selection of freshwater marsh, flooded-timber, and flooded-cropland habitats on the wintering grounds (Davis et al., 2009; Davis and Afton, 2010).

Raptors

Thirty-one species of raptors including owls may be found in the Gulf Coast States at some time during the year. Of these, approximately 18 are considered breeders or year-round residents. Of the species in this group, included are the following families: Cathartidae (black and turkey vulture); Accipitridae (eagles, kites, accipiters, buteos, and osprey; numerous species); Falconidae (4 representatives); Tytonidae (barn owl);and Strigidae (other owls). All raptors are protected under the Migratory Bird Treaty Act. The bald eagle is afforded additional protection from the Bald and Golden Eagle Protection Act (enacted in 1940; 16 U.S.C. 668-668c). Raptors delisted from ESA protection include the bald eagle (delisted on July 9, 2007; 72 FR 37346-37372) and the American peregrine falcon (August 25, 1999; 64 FR 46543-46558). A 5-year status review for the northern aplomado falcon was initiated on March 29, 2010 (75 FR 15454-15456). Results of the status review have not been completed at the time of writing this document; therefore, changes to the status or any additional information is not available at this time. In addition, the Recovery Plan has not been updated since the original plan was written (June 8, 1990; USDOI, FWS 1990b).

Raptors listed as state species of conservation concern include the following: Alabama (swallow-tailed kite, northern harrier, SE American kestrel, and short-eared owl); Florida (Audubon's crested caracara, Florida burrowing owl, Everglades snail kite, osprey, and SE American kestrel); Louisiana (swallow-tailed kite, bald eagle, northern harrier, and short-eared owl); Mississippi (short-eared owl, swallow-tailed kite, bald eagle, osprey, and barn owl); and Texas (swallow-tailed kite, bald eagle, black hawk, gray hawk, white-tailed hawk, zone-tailed hawk, northern aplomado falcon, American peregrine falcon, Mexican spotted owl, and cactus ferruginous pygmy-owl). **Table 4-14** includes information regarding these and other threatened and endangered avian species, which are described in more detail below.

Seven species of raptors (barn owl, broad-winged hawk, Cooper's hawk, great-horned owl, osprey, red-shouldered hawk, and red-tailed hawk) were collected as part of the post-DWH monitoring. Only the osprey appeared to be influenced by oiling (11 collected, 3 visibly oiled, 27% oiling rate) (**Table 4-8**). Interestingly, as of May 12, 2011, no bald eagles were collected as part of the DWH monitoring efforts (**Table 4-8**). Overall, this group had the lowest oiling rate (4 ± 4%) of the seven species groups considered (**Table 4-12**). In addition, this group had the lowest number of birds actually oiled (n = 3) (**Table 4-12**). Effects of the DWH event are addressed in more detail below.

Threatened and Endangered Species

Table 4-14 provides information for each of the 17 species considered herein including its status, critical habitat designations, states in which it occurs, planning areas, and information on the DWH event. Avian species included in this table represent a compilation of those recommended for consideration by the FWS (USDOI, FWS, official communication, 2011c), as well as additional species that can be found in the Gulf Coast States. The following summary and all tables herein represent new information.

Twelve avian species that occur in the CPA are considered with regard to endangered and threatened protections: 1 threatened, 6 endangered, 2 candidate, and 3 delisted (**Table 4-14**). Twelve threatened or endangered avian species are likely to be found breeding or wintering in the CPA (**Table 4-14**). Of the species considered, only the piping plover, whooping crane, least tern, bald eagle, and brown pelican are analyzed for potential effects. The red-cockaded woodpecker, roseate tern, wood stork, Mississippi sandhill crane, Attwater's prairie chicken, northern aplomado falcon, mountain plover, Everglade's snail kite, Cape Sable seaside sparrow, Sprague's pipit, peregrine falcon, and red knot are not considered further because of their status (e.g., candidate or delisted), due to their reliance on more terrestrial habitats to carryout their life-history functions, or because there is little to no data indicating they occur on the OCS. Therefore, these species were not analyzed further as they are not likely to be adversely affected by a CPA proposed action.

Only 3 of the 17 species included in **Table 4-14** are known to be impacted by the DWH event (**Table 4-8**). Of the species considered, the brown pelican had the highest loss (# collected, # oiled, oiling rate) (n = 826, n = 339, 41%), followed by the least tern (n = 106, n = 49, 46%) (**Tables 4-8 and 4-13**). As of May 12, 2011, only a single, unoiled piping plover had been collected (**Table 4-8**). Demographic information and recovery potential for the brown pelican and least tern are provided in **Table 4-13** and are described below.

Following the DWH event, BOEMRE requested reinitiation of ESA Section 7 consultation with NMFS and FWS on July 30, 2010. The NMFS responded with a letter to BOEMRE on September 24, 2010; FWS responded with a letter to BOEMRE on September 27, 2010. The reinitiated consultations are not complete at this time, although BOEM, as lead agency for the consultation, and BSEE are in discussions with both agencies. In the meantime, the current consultation remains in effect and recognizes that BOEM- and BSEE-required mitigations and other reasonable and prudent measures should reduce the likelihood of impacts from BOEM- and BSEE-authorized activities. Further, BOEM has determined, under Section 7(d) of the ESA, that a CPA proposed action is not an irreversible or irretrievable commitment of resources, which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternative measures. The BOEM and BSEE are also developing an interim coordination program with NMFS and FWS while consultation is ongoing.

Piping Plover

Three populations of piping plovers (*Charadrius melodus*) are recognized under the Endangered Species Act: Great Lakes (endangered); Great Plains (threatened); and the Atlantic (threatened) (December 11, 1985; 50 FR 50726-50734). The Great Plains population breeds primarily along the Missouri River system and its tributaries, as well as alkali wetlands and lakes in the Dakotas, Montana, and in prairie Canada; the population winters primarily along the Gulf of Mexico (Elliott-Smith and Haig, 2004; Haig et al., 2005; Roche et al., 2010). The Great Lakes population breeds primarily along the shores and cobble beaches and associated islands with similar substrate in the Great Lake states and Canadian provinces (Stucker et al., 2010); the population winters primarily along the south Atlantic Coast with the highest densities between St. Catherine's Island, Georgia, to Jacksonville, Florida, but as far west as the Laguna Madre, Texas (Stucker and Cuthbert, 2005; Gratto-Trevor et al., 2009). The Atlantic Population breeds on beaches and barrier islands from Atlantic Canada south to North Carolina and winters primarily along the Atlantic Coast (Nicholls and Baldassarre, 1990a; Gratto-Trevor et al., 2009; Hecht and Melvin, 2009). Possibly as high as 75 percent of all breeding piping plovers regardless of population affiliation may winter in the Gulf of Mexico, spending up to 8 months on the wintering grounds. Refer to Elliott-Smith and Haig (2004) and Gratto-Trevor et al. (2009) for additional information specific to each population. They begin arriving on the wintering grounds in July and continue arriving through September. In late February, piping plovers begin leaving the wintering grounds to migrate back to their breeding sites. Northward migration peaks in late March, and by late

May most birds have left the wintering grounds. A Five-Year Review was completed on September 29, 2009, with recommendations that their status remain unchanged. Habitat loss and degradation due to commercial, residential, and recreational developments on both breeding and wintering areas is the likely cause for declines. Similar to the least tern, alteration of natural water flow regimes on the Missouri River has contributed to loss of breeding habitat for the Northern Great Plains Population. The piping plover is considered a state species of conservation concern in all Gulf Coast States (Texas, Louisiana, Mississippi, Alabama and Florida) considered. Unlike the more optimistic population trajectory for the Interior least tern, that of the piping plover suggests declines for at least two of the three breeding populations (Great Lakes and Atlantic) (Haig et al., 2005; Roche et al., 2010).

Twelve different critical habitat rules have been published for piping plovers including designations for coastal wintering areas of the following states: North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas (July 10, 2001; 66 FR 36038-36086). Specifically, there are 20 units (parcels of land designated as critical habitat) in western Florida south to Tampa Bay, 3 areas in Alabama, 15 in Mississippi, 7 in Louisiana, and 18 in Texas. Critical wintering habitat includes the land between mean low water and any densely vegetated habitat that is not used by the piping plover. The habitats used by wintering birds include beaches, mud flats, sand flats, algal flats, and washover passes (areas where breaks in the sand dunes result in an inlet). Wintering plovers are dependent on a mosaic of habitat patches and move among these patches depending on local weather and tidal conditions. It has been hypothesized that specific wintering habitat, which includes coastal sand flats and mud flats in close proximity to large inlets or passes, may attract the largest concentrations of piping plovers because of a preferred prey base and/or because the substrate color provides protection from aerial predators due to cryptic blending camouflage color (Nicholls and Baldassarre, 1990b). Seventy-five percent of Great Lakes breeders were found along the Atlantic Coast from North Carolina to the Florida Keys (also used by 77% of eastern Canada breeders), compared with only 7 percent of breeders from the U.S. Northern Great Plains and 4 percent from Prairie Canada (Gratto-Trevor et al., 2009, Figure 1). In comparison, Mississippi, Louisiana, and Texas coasts harbored 71 percent of observed birds from the U.S. Northern Great Plains and 88 percent of those from Prairie Canada, but only 2 percent of Great Lakes breeders (Gratto-Trevor et al., 2009; USDOI, FWS, 2009a).

The informal consultation process with this Agency (September 17, 2007) relative to Gulf of Mexico OCS oil and gas lease sales under the 2007-2012 Five-Year Program analyzed the scenario for the piping plover, and FWS concluded "that the proposed action is not likely to adversely affect the piping plover or its Critical Habitat" (USDOI, FWS, 2007a). As of May 12, 2011, only a single, unoiled piping plover had been collected and reported as part of monitoring efforts related to the DWH event (**Table 4-8**) (USDOI, FWS, 2011b). This suggests that, for the piping plover and some other species, they simply were not in the area to be oiled during the DWH event, at least through June-early July. Migration timing varies by species, but for at least part of the time oil was flowing, the bulk of these species were not in areas directly affected by the DWH event. Although data remain incomplete on potential indirect impacts to the piping plover and its habitat from the DWH event, at this time it does not appear that there are population-level impacts for this species.

Whooping Crane

Whooping cranes (*Grus americana*) are found only in North America. They currently exist in the wild at three locations and in captivity at nine sites (Canadian Wildlife Service, 2007; USDOI, FWS, 2009b). More recently, a release site (White Lake Wetlands Conservation Area, Vermilion Parish) was added in Louisiana (**Table 4-14**), with a release of 10 birds on February 22, 2011. Whooping cranes in Louisiana (February 3, 2011; 76 FR 6066-6082) and Florida (June 26, 2001; 66 FR 33903-33917) represent nonessential, experimental populations; "the population is considered experimental because it is being (re)introduced into suitable habitat that is outside of the whooping crane's current range, but within its historic range. It is designated not essential because the likelihood of survival of the whooping crane, as a species, would not be reduced if this entire population was not successful and was lost." To date, only 3 of the original 10 released cranes remain; an additional release of 16 cranes occurred on December 1, 2011. As of April 2009, the three wild populations were estimated at 365 individuals (USDOI, FWS, 2009b, p. 7). This includes the following: 247 individuals in the only self-sustaining Aransas-Wood Buffalo National Park Population that nests in Wood Buffalo National Park and adjacent areas in Canada and winters in coastal marshes in Texas; 30 individuals from the nonmigratory Florida

Population in central Florida; and 88 individuals that migrate between Wisconsin and Florida in an eastern migratory population (USDOI, FWS, 2009b). All of the wild populations are listed as endangered. The majority of the Aransas-Wood Buffalo National Park Population migrates down through the Dakotas, Nebraska, Kansas, and Oklahoma before arriving on the wintering grounds in the coastal marshes and estuarine habitats along the Gulf Coast in the Aransas National Wildlife Refuge in Texas (USDOI, FWS, 2009b, Figure 1). Another wild flock was created with the transfer of wild whooping crane eggs from nests in the Wood Buffalo National Park to be reared by wild sandhill cranes in an effort to establish a migratory Rocky Mountains Population (Canadian Wildlife Service, 2007). This population summers in Idaho, western Wyoming, and southwestern Montana, and it winters in the middle Rio Grande Valley, New Mexico. The third wild population is the first step in an effort to establish a nonmigratory population in Florida (Canadian Wildlife Service, 2007). Thus, as of April 2009, there were a total of 516 whooping cranes in North America.

The whooping crane is considered endangered throughout its range in the U.S. except where nonessential, experimental flocks have been established. The Gulf Coast States that have these nonessential, experimental flocks include Alabama, Louisiana, Mississippi, and Florida (**Table 4-14**); also, wild whooping cranes may rarely occur as transients in Mississippi and Alabama, but they are not known to breed in either state. The whooping crane was unofficially "listed" in 1967 as threatened, then reclassified as endangered in 1970, being grand-fathered into ESA in 1973. It was listed primarily due to overhunting and habitat loss. A 3rd Revision to the Recovery Plan (combined Canadian Wildlife Service and FWS) was completed on May 29, 2007. The original Recovery Plan was approved on January 23, 1980. Initiation of the Five-Year Status Review was provided on March 29, 2010 (75 FR 15454-15456). Critical habitat occurs in nine zones in six states, mostly on National Wildlife Refuges (from north to south); Grays Lake National Wildlife Refuge and vicinity (Idaho), Monte Vista National Wildlife Refuge and Alamosa National Wildlife Refuge (Colorado), Platte River Bottoms between Lexington and Dehman (Nebraska), Cheyenne Bottoms State Wildlife Management Area (Kansas), Quivira National Wildlife Refuge (Kansas), Bosque del Apache National Wildlife Refuge (New Mexico), Salt Plains National Wildlife Refuge (Oklahoma), and Aransas National Wildlife Refuge (Texas) (USDOI, FWS, 2009b, Figure 1). The only critical habitat in the Gulf of Mexico is in the WPA (Texas) (**Table 4-14**).

At the time of the informal consultation with this Agency (September 14, 2007), FWS determined that "no direct loss of whooping crane wintering habitat is anticipated, and further that ". . . it is the Service's belief that those reductions (OSRA oil spill probabilities of contacting Critical Habitat) make the likelihood of contact extremely low" (USDOI, FWS 2007a). Finally, concluding with ". . . the Service concurs with your determination that the proposed action is not likely to adversely affect the whooping crane or it's Critical Habitat." As of May 12, 2011, no whooping cranes had been collected as part of the post-DWH monitoring (**Table 4-8**) (USDOI, FWS, 2011b). For the CPA, the Louisiana nonessential experimental flock was only introduced after the DWH event and would therefore not be expected to have suffered direct impacts from the DWH event.

Least Tern

The Interior least tern (*Sterna antillarum*) was listed as endangered on May 28, 1985 (50 FR 21784-21792) throughout much of its breeding range in the Midwest. This designation does not provide or extend ESA protection to the breeding population of Gulf Coast "population" of least terns. Similarly, ESA protection for breeding least terns only applies to certain segments or areas of Louisiana, Mississippi, and Texas (**Table 4-14**). The species was listed primarily due to alteration (i.e., dams) of the natural river dynamics primarily on the Mississippi and Missouri River systems (other rivers also, e.g., Red, Ohio, Wabash, Arkansas) but also due to recreational disturbance of nesting islands and succession of island nesting habitat (i.e., encroachment of woody plants) (USDOI, FWS, 1990a; Kirsch and Sidle, 1999). The Interior least tern is considered a state species of conservation concern in all Gulf Coast States considered except Alabama. As of 1995, the Interior Population of least terns had exceeded the recovery goal of 7,000 birds, largely owing to productivity along a 901-km (560-mi) stretch of the lower Mississippi River (Kirsch and Sidle, 1999; Szell and Woodrey, 2002). However, numbers for most breeding areas have not achieved recovery plan objectives (Kirsch and Sidle, 1999). Population trend estimates were significant for 7 (5 positive, 2 negative) of 31 local areas for which a trend could be calculated (Kirsch and Sidle, 1999).

No critical habitat rules have been published for this species. Three U.S. subspecies are recognized by the American Ornithologists Union, and the California and Interior least terns are both listed as endangered. The third subspecies, the Eastern least tern is not federally listed, but is considered as threatened or endangered in most states in which it occurs. The Recovery Plan was completed on September 19, 1990. A Notice of Initiation for Review occurred on April 22, 2008 (73 FR 21643-21645), but no subsequent decisions regarding its status have been made. Least terns are known to breed not only at inland lakes and riverine habitats in Texas, Louisiana, and Mississippi but also in coastal areas in Louisiana, Mississippi, and Florida (Jackson and Jackson, 1985; Szell and Woodrey, 2002; Mazzocchi and Forys, 2005). Though the majority of inland breeding least terns are thought to depart the continental U.S. to winter along the coasts of Mexico, Central and South America, Argentina, and Brazil, some unknown segment winters along coastal beaches and offshore barrier islands along the northern Gulf of Mexico (Thompson et al., 1997). Although there is some spatial and annual variation in breeding indices, the Interior least tern population considered herein appears to be relatively stable (Kirsch and Sidle, 1999).

During informal consultation (September 17, 2007), FWS stated that the Interior Population of least terns was "not analyzed further because of the species' distance from the potential impact area." Further, no determination was made by this Agency and no FWS concurrence was provided at that time (USDOI, FWS, 2007a). As of May 12, 2011, 106 (49 oiled; 46% oiling rate) least terns had been collected and reported as part of monitoring efforts related to the DWH event (**Table 4-8**) (USDOI, FWS, 2011b). Due to the timing of the oil spill and the timing of collections for this species, it is highly probable that all individuals collected were from the nonfederally listed subpopulation of least terns breeding in the Gulf of Mexico and not from the federally listed Interior Population of least terns, which was likely not present near the coast at the time of the DWH event and aftermath.

Bald Eagle

Certain population(s) of the bald eagle (*Haliaeetus leucocephalus*) were listed on February 14, 1978 (43 FR 6230-6233). Specifically, the original listing (March 11, 1967) only considered the Southern bald eagle for listing. It was originally listed due to population-level effects (e.g., eggshell thinning) from organochlorine pesticides such as DDT/DDE. Once the use of this family of pesticides was banned, the affected bald eagle populations responded relatively quickly. The 1978 *Federal Register* notice included listing all bald eagles in the conterminous 48 states as endangered except those populations breeding in Washington, Oregon, Minnesota, and Michigan. Five recovery plans were completed: Southwestern Bald Eagle Recovery Plan (September 8, 1982); Northern States Bald Eagle Recovery Plan (July 29, 1983); Recovery Plan for the Pacific Bald Eagle (August 25, 1986); Southeastern States Bald Eagle Recovery Plan (April 19, 1989); and Chesapeake Bay Bald Eagle Recovery Plan (September 27, 1990). A Special Rule regarding take under the Bald and Golden Eagle Protection Act was published on June 5, 2007 (72 FR 31141-31155). On July 9, 2007, the bald eagle was delisted (72 FR 37346-37372). The Post-Delisting Monitoring Plan was completed on May 25, 2010, with a follow-up Notice of Availability on June 4, 2010 (75 FR 31811). On February 25, 2010, FWS completed a 12-Month Finding on a Petition To List the Sonoran Desert Population of the Bald Eagle as a Threatened or Endangered Distinct Population Segment, concluding that the this population is not significant in relation to the remainder of the taxon (i.e., bald eagles in North America) and further that Sonoran Desert Area population (8 counties in Arizona) did not represent a Distinct Population Segment, and therefore, did not warrant listing. However, this population will remain listed as threatened until that time the U.S. District Court of Arizona dissolves its injunction (March 6, 2008; see 75 FR 8601 8621-8621). No critical habitat rules were ever published for this species.

Within the CPA, Louisiana and Mississippi consider the bald eagle as a state species of conservation concern. Bald eagles continue to receive protection under the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712) and the Bald and Golden Eagle Protection Act of 1940 (16 U.S.C. 668-668c). A population estimate of 9,789 breeding pairs in 2006 (well above the recovery objective) was obtained by FWS (USDOI, FWS, 2009c). This estimate includes the following number of breeding pairs: Florida (n = 1,133); Alabama (n = 77); Mississippi (n = 31); Louisiana (n = 284); and Texas (n = 156). The Post-Delisting Monitoring Plan (USDOI, FWS, 2009c) will monitor the status of the bald eagle by collecting data on occupied nests over a 20-year period with sampling conducted once every 5 years beginning in 2009. The Plan will continue the nest check monitoring activities conducted by State wildlife agencies over the past years and incorporate additional area sample plots. Bald eagles (and other raptors) remain susceptible to mortality through secondary ingestion (consuming contaminated prey/carcasses) lead poisoning (Scheuhammer and Norris, 1995; Rattner et al., 2008), persistent organochlorines (Elliott et al., 1996), mercury (Wood et al., 1996), and other environmental contaminants (Anthony et al., 1993; Bowerman et al., 1998).

During the most recent informal consultation (September 17, 2007), FWS concurred with this Agency's determination that a CPA proposed action "was not likely to adversely affect this species" (USDOI, FWS, 2007a). As of May 12, 2011, no bald eagles had been collected and reported as part of monitoring efforts related to the DWH event (**Table 4-8**) (USDOI, FWS, 2011b).

Brown Pelican

The eastern brown pelican (*Pelecanus occidentalis*) was nearly extirpated from North America between the 1950's and 1970's when pesticides entering the marine food web caused major population declines. The pesticide endrin resulted in the direct mortality of pelicans, whereas DDT reduced reproductive success through eggshell thinning. It was initially listed under the Endangered Species Conservation Act of 1969, in the United States List of Endangered Foreign Fish and Wildlife on June 2, 1970, and also in the United States List of Endangered Native Fish and Wildlife on October 13, 1970. These lists were republished on January 4, 1974 (39 FR 1171), after passage of the Endangered Species Act of 1973. Three Recovery Plans were completed, all in the 1980's: Recovery Plan for the Eastern Brown Pelican (August 1, 1980); California Brown Pelican Recovery Plan (February 3, 1984); and Brown Pelican Recovery Plan – Puerto Rico and Virgin Islands Population (December 24, 1986). No critical habitat rules were ever published for this species. A Five-Year Status Review was completed on February 7, 2007, with a recommendation to delist. The Final Rule for delisting the brown pelican throughout its range was completed on November 17, 2009 (74 FR 59444-59472); this rule applies to the entire listed species, which includes all six brown pelican (*Pelecanus occidentalis*) subspecies. As part of the de-listing process, a Draft Post-Delisting Monitoring Plan was implemented (September 30, 2009; 74 FR 50236-50237). The draft Post-Delisting Monitoring Plan proposes to conduct annual monitoring for at least 10 years. The post-delisting monitoring of the brown pelican will consist primarily of annual data collection on colony occupancy and the number of nesting pairs. Information on contaminants will also be collected at 5-year intervals beginning in the first year.

A conservative combined estimate of 50,000 brown pelicans was documented for Texas and Louisiana, prior to its extirpation in Louisiana in the early 1960's (Holm et al., 2003). Pesticide contamination was largely responsible for major pelican declines in Texas (King et al., 1985), whereas endrin contamination of prey fish was considered the cause of its extirpation in Louisiana (Nesbitt et al., 1978; Blus et al., 1979). Beginning in 1968, the Louisiana Department of Wildlife and Fisheries and the Florida Fish and Wildlife Conservation Commission began a reintroduction program with release of 1,276 nestlings from Florida to three sites in Louisiana (Nesbitt et al., 1978; McNease et al., 1984). During the spring of 1975, ~40 percent of the restoration population in Louisiana died as a result of endrin pollution. By the late 1980's, brown pelicans had increased to record numbers in several southeastern states including Florida, North Carolina, and South Carolina, and had increased substantially in Louisiana (Wilkinson et al., 1994). Using data from fixed-wing aerial surveys conducted by the Louisiana Department of Wildlife and Fisheries, Holm et al. (2003) estimated an intrinsic growth rate of 0.25 (1971-2001), with a peak in number of nests (n = 16,405) during 2001. Peak number of nesting colonies occurred in 2000 when 11 colonies were documented. The population in Louisiana appears to have stabilized at around 15,000 nests (Visser et al., 2005). Coastal erosion appears to be reducing available nesting habitat for brown pelicans in Louisiana even though the state contains the largest area of undeveloped coastal barriers in the U.S. (Visser et al., 2005). It should be noted that one of, if not the, largest known breeding colonies (Breton National Wildlife Refuge) of brown pelicans has declined to the point of almost disappearing, with no obvious evidence of adult dispersal (Hunter et al., 2006:24). In 2005 and 2006, brown pelican productivity on Breton National Wildlife Refuge apparently was unsuccessful due to the effects of Hurricane Katrina and related overwashing of beaches and fouling by oil (Hunter et al., 2006, p. 24).

Even though the eastern brown pelican was delisted under the ESA, all Gulf Coast States except Alabama recognize it as a state Species of Conservation Concern. The brown pelican is extremely susceptible to environmental contaminants because of its reliance on the ocean for food resources (i.e., bioaccumulation of contaminants in fish) and because pelicans spend a large proportion of their diurnal activity budgets in the water, increasing potential for exposure. In addition, this species seems fairly susceptible to negative effects from oiling because pelicans spend much time swimming in, diving in, and foraging in the water (Shields, 2002, **Tables 4-8, 4-13, and 4-14**). As of May 12, 2011, 826 brown pelicans had been collected as part of monitoring efforts related to the DWH event, second only behind the laughing gull (n = 2,981, 40% oiling rate) in number of bird collected. Of the 826 pelicans collected, 339 were visibly oiled (41% oiling rate) and of those visibly-oiled birds, 152 were dead (**Table 4-8**) (USDOI, FWS, 2011b). Though efforts at rehabilitation and release were highly publicized, the post-release survival of previously oiled and handled brown pelicans tends to be fairly low with subsequent reductions in reproductive effort (Anderson et al., 1996). Although no numeric population goals were established in the post-delisting monitoring plan (USDOI, FWS, 2009d), there remains the potential for long-term, sublethal effects of oiling from the DWH event on brown pelican populations and the potential for adverse impacts to their continued recovery in the northern Gulf of Mexico.

The eastern brown pelican was still listed at the time of the previous Informal Consultation (September 14, 2007) and was therefore considered in the impact analysis by FWS. At that time, FWS concurred with this Agency that ". . . the proposed action is not likely to adversely affect the brown pelican" (USDOI, FWS, 2007a). In light of the impacts that may be associated with the DWH event, BOEM considers it reasonable and prudent to consider this delisted species as part of the NEPA process. Due to its relatively wide distribution across the northern Gulf of Mexico, it is considered for potential impacts relative to OCS activities in the WPA, CPA, and EPA (if and when the EPA is opened for offshore oil and gas activities) (**Tables 4-8, 4-13, and 4-14**).

Effects of Hurricanes Katrina and Rita on Baseline Conditions

Hurricanes may exacerbate impacts of OCS-related (e.g., coastal infrastructure, platforms, and pipelines) and cumulative impacts on coastal and marine birds considered herein. Hurricanes tend to impact a number of resources that could also be impacted by routine OCS activities and accidental events resulting from OCS activities, including through additional pressures on habitat loss, saltwater intrusion into marshes, the dispersal of discharges, and potential oil spills, among other things. Hurricanes Katrina and Rita have impacted avian habitats throughout the Gulf (Barrow et al., 2007a and 2007b; Dobbs et al., 2009; Brown et al., 2011). Major impacts to avian habitats (coastal marshes, beaches, barrier islands, coastal forests) occurred during both events with effects from Hurricane Katrina primarily in southeastern Louisiana (and coastal Mississippi and Alabama) and from Hurricane Rita in southwestern Louisiana (and Texas). Barras (2007, Figures 1 and 2) documented major declines in fresh (122 mi^2; 316 km^2) and intermediate marsh (90 mi^2; 233.1 km^2) land areas. In addition, brackish (33 mi^2; 85.5 km^2) and saltwater (28 mi^2; 72.5 km^2) marsh land areas also decreased. Michot et al. (2007) and other scientists flew 5,003 mi (8,052 km), logging nearly 65 hours in the aircraft after the hurricanes. These authors considered the ecological impacts moderate to severe. Michot et al. (2007, p. 96) noted that damage to vegetation structure would reduce available nesting and roosting habitat for hundreds of avian species and also that conversion of emergent marsh to open water would exacerbate an already critical landloss situation in Louisiana. Sallenger et al. (2007) documented an 85 percent reduction in the surface area of the Chandeleur Islands and that Dauphin Island had basically migrated landward, both as a result of Hurricane Katrina. Further to the west, Hurricane Rita resulted in major changes to the beaches and areas immediately inland; i.e., 65 ft (19 m) of shoreline retreat with elevation reductions of roughly 2.5 ft (0.8 m) (Stockdon et al., 2007, Figure 3).

In his review of impacts to biological resources of Hurricane Katrina, Sheikh (2005) indicated that there were substantial impacts to several National Wildlife Refuges, potential major impacts to several threatened and endangered species and their habitats, and additional loss to coastal wetlands, and forested habitat. However, he further stated that most of the impacts were anecdotal in nature and that little data were collected before or after to quantify potential impacts to biological resources (Sheikh 2005, p. 2; but see Farris et al., 2007). Hunter et al. (2006) raised concerns for several species (e.g., brown pelicans, royal tern, Forster's tern, and laughing gull), and in particular, the brown pelican which had nearly complete reproductive failures (2005 and 2006) on Breton National Wildlife Refuge, Louisiana. Barrow et al. (2007a, Figure 1) documented a major shift in fall-migrant neotropical landbirds as a result of major damage to the forests in the Pearl River Delta; response up to 5 weeks post-Katrina was a shift to less-disturbed, pine-dominated woodlands. In the same area, Brown et al. (2011a) documented a 57 percent decline in forest canopy cover, resulting in major changes in the avian community composition.

Interestingly, Brown et al. (2011a) documented fairly dramatic increases in both avian species diversity and density when comparing pre- versus post-Katrina point-count (5 minutes, 50-m [164-ft] fixed-radius) surveys; largely owing to major increases in understory species. These results are contrary to anticipated declines in several species of coastal marsh birds and waterbirds, as well as shorebirds due to the major habitat losses incurred by Hurricanes Katrina and Rita (Hunter et al., 2006). Large areas of coastal wetlands were converted to open-water habitat (see above), negatively affecting some avian species (but see below) that relied on these habitats for foraging, roosting, and nesting, or as staging areas during migration.

Impacts from the hurricanes to these habitats certainly have the potential to result in population-level impacts, affecting both distribution and abundance for some species (Rittenhouse et al., 2010). For example, the coastal habitats that were significantly impacted in the northern Gulf of Mexico support nearly 50 percent of the southeastern population of brown pelicans, nearly 75 percent of the population of sandwich terns, 25 percent of the southeastern population of Wilson's plovers, and major proportions (16-42%) for seven other beach-nesting species (Hunter et al., 2002 and 2006; USDOI, FWS, 2010a). Impacts to these habitats could seriously reduce future reproductive performance and affect overall population levels of several species (Hunter et al., 2006; Rittenhouse et al., 2010). Impacts from hurricanes to bottomland forest habitat along the Louisiana and Mississippi coasts represent further loss of avian habitat, affecting many different species; a large proportion of the cavity trees used by the endangered red-cockaded woodpecker at Big Branch Marsh National Wildlife Refuge in St. Tammany Parish, Louisiana, were destroyed. Hurricanes historically have been known to have major negative impacts on red-cockaded woodpecker populations, killing individuals as well as decimating cavity trees (Hooper et al., 1990; Hooper and McAdie, 1995).

Agencies including FWS and USGS have implemented numerous studies and monitoring programs to determine the extent and magnitude of impacts by Hurricanes Katrina and Rita and affected avian populations (e.g., Barrow et al., 2007a and 2007b). After Hurricane Rita, the Chenier Plain in western Louisiana was sampled for plant and animal food for neotropical migrant landbirds (see Barrow, 2007b). Saltwater intrusion, blowdowns, and debris deposits on the forest floor resulted in major reductions in food (insects, invertebrates, fruit) available to neotropical migrant landbirds (Barrow et al., 2007b, p. 151; Dobbs et al., 2009). In particular, canopy forests damaged by hurricanes can greatly reduce availability and diversity of foods available to insectivorous neotropical migrants, primarily through reductions in foraging substrates, as was documented by Dobbs et al. (2009) after Hurricane Katrina. For neotropical migrant landbirds at least, it appears that indirect effects (e.g., habitat loss and alteration, declines in food availability) by hurricanes may be more important than direct effects (mortality; but see Butler, 2000), and in some cases, species diversity and density recovered relatively quickly (1-2 years) to pre-hurricane levels (Barrow et al., 2007a; Dobbs et al., 2009; Brown et al., 2011a). Overall, hurricane-related impacts can result in negative impacts to neotropical migrants adapted to mature forests, but the altered habitat post-hurricane may actually benefit neotropical species adapted to early and mid-successional forests.

Waterfowl distribution in Louisiana apparently shifted to southeastern marshes in fall 2005, possibly as a response to hurricane effects in the southwestern part of the state. Interestingly, in the fall after Hurricane Rita passed through southwestern Louisiana, waterfowl numbers were again high in that part of the state, possibly due to successional effects on submerged aquatic vegetation in that region.. Obviously, hurricane-related impacts will vary spatially and effects will also vary within and among the seven species groups considered. Also, the timing of hurricanes can determine its level of impact for avian species in its path. If, for example, a hurricane occurs during the breeding season, many of the ground-nesting, marsh bird and waterbird nests and nestlings may be decimated, at least locally (see Hunter et al., 2006). Mortality may occur as a direct result of the storm or due to tidal surges and flooding. Depending on the timing, location, and the path of the hurricane, there is the potential to lose entire cohorts during a given event.

The effects of avian habitat loss due to hurricanes are still poorly understood, requiring long-term monitoring not only of the distribution and abundance of various species and their habitat but also for determining important demographic parameters (Brown et al., 2011a). While relevant to reasonably foreseeable impacts on birds, BOEM subject-matter experts have determined that it is not essential to a reasoned choice among alternatives, including the No Action alternative. Hurricanes are part of the dynamic environment of the Gulf and occur periodically; impacts are often difficult to discern from other impacting factors ongoing in the Gulf; the information would be out of date quickly as new storms are experienced; and it is not possible for BOEM to obtain this information within the timeline of this EIS and without exorbitant cost. The BOEM subject-matter experts have applied what scientifically credible information is available, using accepted scientific methodologies.

Effect of the Deepwater Horizon *Event on Baseline Conditions*

The DWH event probably exacerbated the impacts of OCS-related and cumulative impacts on coastal and marine birds. As of May 12, 2011, FWS had reported 102 avian species identified, representing a total of 7,258 individuals collected as part of the post-DWH monitoring efforts (**Table 4-8**). It is important to note that only a fraction of the birds recovered were actually oiled (36% oiled, 47% unoiled, 17% unknown) (**Tables 4-8 and 4-13**). Similarly, considering only the dead birds collected (n = 6,381), a small fraction were oiled (33.2%) compared with unoiled, dead birds (53.1%). Of the dead birds collected, approximately 14 percent were classified as unknown oiling. Search effort alone may explain the large number of unoiled birds recovered during the DWH event monitoring efforts. It should also be noted that the mortality associated with the DWH represents only a small proportion of the total annual mortality compared with other anthropogenic sources (**Table 4-7**). Relative to the number of birds collected post-DWH event, however, it has been well documented that the number of birds collected immediately following a spill actually represents a small fraction (0-59% with a mean recovery rate of 17%; Piatt and Ford, 1996) of total avian mortality (**Tables 4-8 and 4-15**). Five species of diving birds, 26 species of seabirds, 12 species of shorebirds, 21 species of passerines, 21 species of marsh and wading birds, 12 species of waterfowl, and 7 species of raptors are known to have been impacted by the DWH event (**Table 4-8**).

Of the seven species groups considered herein, seabirds were numerically the most impacted group (n = 5,309) and they had the highest oiling rate (34%) (**Table 4-12**). The species' group with the next highest oiling rate (33%) was waterfowl (n = 52). In order of impact based on oiling rate were seabirds (34%), waterfowl (33%), diving birds (27%, n = 106), marsh and wading birds (26%, n = 378), passerines (19%, n = 73), shorebirds (18%, n = 81), and raptors (4%, n = 17) (**Table 4-12**). Overall, the five most impacted species, based on number collected, were as follows (number collected, oiling rate): laughing gull (n = 2,981, 40%); eastern brown pelican (n = 826, 41%); northern gannet (n = 475, 63%); royal tern (n = 289, 52%); and black skimmer (n = 253, 22%) (**Tables 4-8 and 4-13**). Of these species, only the northern gannet breeds outside the Gulf of Mexico; i.e., in the north Atlantic along the eastern coast of Canada.

Presumably, the bulk of the northern gannets collected were immatures based on the timing of the event and differential migration among age classes (Montevecchi, official communication, 2011). Based on the literature, knowledge of species' habitat associations, and hypothesized differences among species in detection probabilities during oiled-bird surveys, it seems reasonable to deduce that oiling rates for passerines were likely biased high, but oiling rates for shorebirds were likely biased low (**Tables 4-8 and 4-12**). This bias for shorebirds was likely due to the small sample sizes of unoiled birds compared with the number of oiled birds collected; BOEM subject-matter experts would not expect passerines to have a higher oiling rate than shorebirds.

Research to determine oil vulnerability indices (corrected for temporal and spatial differences and density) for avian species breeding and wintering in the Gulf of Mexico is needed. Unfortunately, data included herein (USDOI, FWS, 2011b) only spans September 14, 2010-May 12, 2011. In addition, there is no sex-age composition information available with which to make inferences. Sex-age composition is vital to making inferences from the sample since not all sex-age classes are (1) equally represented in the oiled sample and (2) contribute equally to population dynamics for a given species (Ricklefs, 1983a and 1983b; Croxall and Rothery, 1991). If direct impacts were more concentrated on a specific age group (e.g., on a species age group that had not yet reached sexual maturity), there could be delayed impacts to the species, such through age-specific reductions in reproductive success during a future breeding season, as described below. As well, data related to search effort, both spatially and temporally, are also lacking (Hampton and Zafonte, 2005; Ford, 2006), although one would expect that search effort may have declined somewhat after the Macondo well was capped and declined significantly in the months following capping and killing of the well (**Figure 4-17**).

Figures 4-15 and 4-16 represent locations of dead and live birds recovered, respectively (USDOI, FWS, 2011b). It is difficult to infer from these figures if the size of the points actually represent the number and spatial distribution of recovered birds or is simply a function of search effort (which almost certainly varied spatially). From **Figures 4-15 and 4-16**, there is no way to determine how spatial variation in search effort affected the number of birds found at a given site. Search effort offshore in proximity to the well was almost certainly not equal to effort expended in the nearshore environment and along the shoreline, beaches, and barrier islands (see Hampton and Zafonte, 2005). This spatial variation in effort could result in overestimating impacts to some species (e.g., mourning dove) or species groups (e.g., passerines) while underestimating impacts to other species (e.g., northern gannet and common loon) or species groups (e.g., seabirds and diving birds), particularly since these latter species tend to utilize primarily offshore habitat. **Figure 4-17** suggests that the contribution of individual birds to the sum total of birds recovered and identified declined dramatically beginning on or before October 20, 2010, providing some evidence of declines in either search effort (collecting birds), lab time (identifying collected birds to species), data management (QA/QC of individual records), number of oiled birds collected by search crews, or all of the above.

It is difficult to assess a bird species' population response to major mortality events without some knowledge of its life-history strategy and an understanding of the various demographic parameters driving the population (Velando and Freire, 2002; Stahl and Oli, 2006) (**Table 4-13 and Figures 4-18 and 4-19**). In **Figure 4-19**, each box (state variable) and bowtie (transition probability) requires a demographic value obtained from extensive field research (e.g., Cooke et al., 1995). Within a bird species group, there will be among-species variation in population limiting factors, as well as a species' capacity to recover from catastrophic loss (Newton, 1998). At the same time, demographic and environmental variation will interact, resulting in temporal variability in growth, survival, and reproduction for a given species (**Figure 4-18**) (Sæther et al., 2004). For some species, the majority of annual mortality occurs on the breeding grounds (Sargeant and Raveling, 1992), for some on the wintering grounds (Goss-Custard et al., 1995a, 1995b), and for others, it may occur during migration (Stokke et al., 2005; Newton, 2006). For a population to remain stable ($\lambda = 1$), the adult breeding component of the population must produce enough offspring that survive to breeding age (i.e., recruitment) to replace the adults that die; that is, # of births + # of immigrants = # of deaths + # of emigrants (Perrins, 1991). There tends to be among-species and among sex- and age-class variation in survival, reproduction, and mortality such that not all species' populations are at the same state or on the same population trajectory when a perturbation event (e.g., oil spill, major disease outbreak, hurricane, etc.) occurs (Koons et al., 2005 and 2007).

Table 4-13 provides demographic information (where available) for the Top 10 most impacted species associated with the DWH event. Most of the species impacted were seabirds (**Table 4-13**), and this species group had the largest number of carcasses (n = 5,309) collected for the seven species' groups considered (refer to **Tables 4-8 and 4-12**). Of the representative species in **Table 4-13**, excepting the clapper rail, these species tend to be relatively long-lived, exhibit delayed maturity, and have small clutch sizes (Ricklefs, 1977 and 1990; Ricklefs and Bloom, 1977). Therefore, most of these species would have low recovery potential, with the greater shearwater, northern gannet, and common loon exhibiting delayed or longer recovery period, whereas the clapper rail or black skimmer would probably recover fairly quickly (≥1 yr). In general, for relatively long-lived avian species with low reproductive potential, delayed maturity, and small clutch size, their population tends to be most sensitive (population growth rate (λ) = 1 for "stable" population) to even small changes in adult survival, particularly for females (Oro et al., 2004; Borkhataria et al., 2008). In addition, for some species, e.g., greater shearwater, northern gannet, and common loon, a large segment of the population is comprised of non-breeding age individuals. These individuals do not have the capacity to affect population-level reproductive potential until they attain sexual maturity. In situations where the loss of non-breeders occurred, effects at the population level would not be realized immediately. For many of the species considered (except possibly clapper rail), mortality after the first year may be additive (in addition to other sources of natural mortality) given what we know about the species' demography (Piatt et al., 1990a, pp. 128-129; Croxall and Rothery, 1991, pp. 272-273). For most species herein, there is insufficient data to conduct in-depth perturbation, sensitivity, or population viability analyses (Boyce, 1992; Beissinger and Westphal, 1998), even though these types of analyses would be important for evaluating an activity's impacts to a given bird population (MacLean et al., 2007; Martin et al., 2009; McGowan and Ryan, 2010). As a result, a large amount of uncertainty surrounds potential effects of a given event or perturbation to a given species or its population (Pullin et al., 2004; Prato, 2005). In-depth, species-specific analyses are being considered and undertaken as part of the NRDA process, and this information may not be available for several years, even for the most impacted species (**Tables 4-8 and 4-13**).

In the analysis above, effects associated only with direct mortality relative to the DWH event have been considered in this section. Nevertheless, there is a high probability of underestimating the impacts of oil spills on avian species potentially encountering oil, particularly for the long-term, sublethal effects. Negative effects to affected individuals may persist for years after the event and requires a long-term commitment in resources (i.e., money, personnel, and time) to monitor potentially affected populations. Indirect effects may persist for years after exposure reducing the capacity of affected individuals within the population to contribute to recovery due to physiological disorders through damage to vital organs (i.e., liver and kidney) (Balseiro et al., 2005; Oropesa et al., 2007; Pérez et al., 2008) or insulative capacity of feathers increasing risk of death due to exposure (Stephenson, 1997; O'Hara and Morandin, 2010). Sublethal effects of oil could ultimately result in reductions in long-term survival or lower reproductive success for some species of birds (Trivelpiece et al., 1984; Fry et al., 1986; Esler et al., 2000b). In addition, oiling of a single individual within a mated pair may negatively influence pairing behavior and pair bonds (Pérez et al., 2010), incubation behavior, nest success and egg hatchability (Szaro et al., 1978a and 1978b; Butler et al., 1988), foraging behavior and provisioning rate, growth rates of adults and surviving fledglings with the potential influence food-web dynamics (Peterson, 2001; Velando et al., 2010), and the transfer of polycyclic aromatic hydrocarbons to other species (e.g., raptors feeding on oil-affected individuals; see Zuberogoitia et al., 2006). Long-term, sublethal, chronic effects may exceed immediate losses due to direct mortality (i.e., oiled birds) if such residual effects influence a significant proportion of the population or disproportionately impact an important population segment, e.g., adult females (Petersen et al., 2003; Martínez-Abraín et al., 2006; Alonso-Alvarez et al., 2007b). In addition, the long-term, sublethal effects from dispersants (1.84 million gallons; Oil Spill Commission [2011g]) used during the DWH event are largely unknown (but see Albers and Gay, 1982; Singer et al., 1995; Scarlett et al., 2005). Finally, the unquantified, unintended consequences of a massive cleanup effort may have resulted in considerable negative effects to beach nesting and beach roosting species in the spill area (American Bird Conservancy, 2010). Such effects may include, but are not limited to, habitat loss or alteration, egg loss, nest abandonment, nestling mortality, and disturbance-related impacts that may have resulted in increased predation to eggs, nestlings, and fledglings, or death due to exposure (National Audubon Society, Inc., 2010).

Threatened and endangered bird species may be the most impacted because they are starting at a point below what is considered a stable population prior to any major perturbation. Or, the population trajectory is indicative of a decline before the perturbation. Most of these species were federally listed due to habitat loss or fragmentation, being habitat or food specialists, having a life-history strategy that limits their ability to quickly recover from losses, or some combination of factors (Walters, 1991; Curnutt et al., 1998; Root, 1998). Therefore, any additional losses to listed populations could lead to steeper declines in population trajectories, longer recovery periods, or in some cases, local extirpation (Beissinger, 1995; Benton, 2003).

The oil from the DWH event (USDOI, FWS, 2011b) has had serious direct and indirect impacts to coastal and marine birds, and such effects were certainly far more serious for birds using the CPA than the WPA, since the extent of the spill remained east of the WPA boundary. Further, it is unknown what the long-term impacts are to respective species' populations at this time (**Tables 4-8, 4-12, and 4-13**; **Figures 4-16 and 4-17**). That said, we lack data on spatial and temporal aspects of search effort, and more importantly, data on sex-age composition of the collected sample. Sex-age composition data would be extremely beneficial because it provides insights into the short- and long-term impacts for a given avian species, as well as information necessary to gauge a species' recovery potential. It is reasonable to infer from the limited data available that not all species groups were impacted similarly and that not all species within a group were impacted similarly (**Table 4-12**). There may be delayed effects for some species due to major impacts to certain year classes, i.e., subadults, such that the impacts will not be realized until the dead individuals would have attained breeding age. Individual life-history strategies, starting population size and trajectory, and sex and age composition of the population prior to the DWH event will ultimately dictate the impacts at the population level. It should also be noted, the total body count and the total modeled estimate of avian mortality from an oil spill does a poor job of indicating "effect" or "impact" to a given species' population, as not all birds are created equal (i.e., reproductive age females are "worth" more to the population). To address this, some form of calculating/deriving lost-bird-years and recovery to baseline conditions is necessary and requires knowledge of the age-sex composition of the oiled sample of birds, as well as age-sex structure of the target population. Refer to Donlan et al. (2003), Sperduto et al. (2003), and Zafonte and Hampton (2005, Figure 1) regarding compensatory mitigation for avian species' impacts following oil spills.

Unavailable information on the effects to coastal and marine birds from the DWH event (and thus changes to the avian baseline in the affected environment) makes an understanding of the potential impacts from a CPA proposed action less clear. The BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to coastal and marine birds. The BOEM believes that this incomplete or unavailable information regarding effects of DWH on birds may be essential to a reasoned choice among alternatives, particularly for species listed as endangered or threatened. Relevant data on the status of bird populations after the DWH event may take years to acquire and analyze through the NRDA process, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted methods and approaches.

4.2.1.16.2. Impacts of Routine Events

Background/Introduction

The possible effects of routine activities on coastal and marine birds of the Gulf of Mexico and contiguous waters and wetlands are discussed below. Birds, and seabirds in particular, are generally considered reasonable indicators or monitors of environmental change and pollution, as well as food resources because of their reliance on the ocean for most of their life-history requirements; primarily as foraging habitat (Furness, 1993; Burger and Gochfield, 2001). Federally listed threatened or endangered bird species are included in this discussion because the routine events potentially impacting these species are similar to that of nonlisted species. However, it is recognized that any negative effects from these events would likely have a greater net negative effect on listed avian species. The BOEM and FWS have developed a Memorandum of Understanding (USDOI, FWS and USDOI, MMS, 2009) to "meet the requirements under Section 3 of Executive Order 13186 (66 FR 3853, January 17, 2001) concerning the responsibilities of Federal agencies to protect migratory birds."

Major potential impact-producing factors for marine birds in the offshore environment include the following:

- habitat loss and fragmentation (Fahrig 1997 and 1998);
- behavioral effects primarily due to disturbance from OCS helicopter and service-vessel traffic and associated noise (Habib et al., 2007; Bayne et al., 2008);
- mortality due to exposure and intake of OCS-related contaminants, e.g., produced waters (Wiese et al., 2001; Fraser et al., 2006) and discarded debris (Robards et al., 1995; Pierce et al., 2004);
- sublethal, chronic effects from air emissions (Newman, 1979; Newman and Schreiber, 1988); and
- mortality and energetic costs associated with structure presence and associated light (Russell, 2005; Montevecchi, 2006).

Permitted OCS oil and gas activities produce four broad classes of pollutants: air (NRC, 2005a); water (Holdway, 2002; NRC, 2003); sound (Francis et al., 2009; Bayne and Dale, 2011); and light (Longcore and Rich, 2004; Gehring et al., 2009). Negative effects from any of these four types of pollutants probably have the greatest net negative effect on threatened and endangered avian species compared with nonthreatened and nonendangered species (**Chapter 4.1.1.14.1 and Table 4-14**).

To date, many of these factors have been poorly studied in an offshore environment relative to impacts to migratory birds. However, there remain many assumptions regarding potential effects of these various impact-producing factors and efficacy of regulations for eliminating or minimizing their impacts

(Fraser and Ellis, 2008; Fraser et al., 2008). For purposes of this EIS, the Bureau of Ocean Energy Management's subject-matter experts have conservatively assumed the potential for impacts and have discussed these potential impacts below. For additional information, see also **Chapters 4.1.1.1 and 4.1.1.2**.

All avian species show varying levels of fidelity to both breeding and wintering areas. Therefore, discussions of available, unaltered habitat should be kept in context. Without a thorough understanding of species' habitat use and preferences, a species' ability to locate and colonize alternative habitat, and the population structure (i.e., metapopulation theory; Esler, 2000), it is difficult to make inferences regarding the ability of birds to emigrate and colonize novel, undisturbed habitat (assuming it is available) (Fahrig 1997, 1998, and 2001).

Threatened and endangered species may be harmed by any impact to its population (particularly to breeding-age females), reproductive potential, or destruction of or disturbance to key wintering, staging, or breeding habitats (Fahrig, 2002), as well as to changes in preferred prey density, abundance, or distribution. The generally small population size, specialized habitat preference and use, and typically low reproductive potential limit threatened and endangered species from quickly recovering from mortality events (Root, 1998; Reed et al., 2003).

Habitat Loss and Fragmentation

The greatest negative impact to coastal and marine birds is the loss, alteration, and fragmentation of preferred or critical habitat (Fahrig, 1997 and 1998). This is particularly true for threatened or endangered species, whereby populations tend to be at or approaching some critical threshold in abundance (Dennis et al., 1991; Belovsky et al., 1994).

Pipeline landfalls, terminals, and other onshore OCS-related infrastructure can destroy or fragment otherwise suitable avian habitats, e.g., wetlands, resulting in displacement of associated avian communities (**Figures 3-5, 3-6, 3-7, 4-21, 4-22, and 4-24**). Seabird nesting colonies (e.g., terns, gulls, and brown pelicans) are particularly sensitive to disturbance and habitat alteration or loss, and known colonies should always be avoided by construction activities. Environmental regulations (Section 404 of the Clean Water Act; U.S. Dept. of the Army, COE) require restoration (or mitigation) of wetlands modified (e.g., drain, fill, dredge) or destroyed by pipelaying barges and associated onshore infrastructure. However, onshore pipelines cross a wide variety of coastal environments and can therefore affect certain species (e.g., passerines) often not associated with freshwater, marine, or estuarine systems (**Tables 3-13, 3-15, and 3-16**; **Figures 3-5, 4-21, and 4-22**).

Fidelity to coastal and marine roosting, nesting, and foraging sites likely varies among species and within and among years for a given species along the Gulf Coast. Site abandonment along the northern Gulf Coast has often been attributed primarily to habitat loss and fragmentation, and also excessive human disturbance (Visser et al., 2005; LeDee et al., 2008). For a detailed description of wetland habitat loss along the Louisiana Gulf Coast, refer to Gosselink et al. (1998) and Stedman and Dahl (2008); see also **Chapters 4.2.1.4.1-4.2.1.4.4**.

Many of the overwintering shorebird species remain within relatively well-defined, winter-use areas throughout the season, and some species exhibit among-year wintering site fidelity, at least when not disturbed by humans (e.g., piping plover; Drake et al., 2001). These species are particularly vulnerable to localized impacts resulting in habitat loss or fragmentation unless they disperse to other favorable habitats when disturbed. This assumes that such habitats are available, in proximity to, and are of similar or greater quality compared with the disturbed habitat (Dolman and Sutherland, 1995; Sutherland, 1998; Johnson, 2007).

Birds may relocate from an impacted habitat to an alternative habitat, although there are a number of factors that may affect this ability and success (Boulinier and Lemel, 1996). However, the newly occupied habitat may be of lesser quality, resulting in reduced survival and reproduction (e.g., Knutson et al., 2006; Pidgeon et al., 2006). This may have short-term or long-term implications depending on the species (Block and Brennan, 1993; Battin, 2004). In their study of non-OCS oil and gas development at Padre Island National Seashore in Texas, Lawson et al. (2011) documented declines in abundance of several species of wintering passerines with decreasing distance from roads. However, the authors did not detect a difference in abundance among active drilling sites, active pumping stations, abandoned well sites, or roads (Lawson et al., 2011, Figure 1).

Helicopter and Vessel Traffic

Disturbance effects related to OCS activities (e.g., air and vessel traffic) can have variable impacts to avian populations depending on the type, intensity, frequency, duration, and distance to the disturbance source (Conomy et al., 1998a; Fernández-Juricic et al., 2002; Blumstein, 2003). For birds, hearing sensitivity seems most acute in the range of 1-5 kHz, similar to the most sensitive mammals in this range; above and below that range avian performance appears to be inferior (Manci et al., 1988, p. 32). Birds vocalize as a form of communication for predator detection-avoidance, food-finding, and during migration. More importantly for many avian species, aural communication (i.e., calls or songs) is used for locating mates, determining mate quality, and maintaining pair bonds (Welty and Baptista, 1988). Anthropogenic sound, i.e., noise pollution, may mask or otherwise interfere with avian communication (Bayne and Dale, 2011). Disturbance-related impacts do not typically result in direct mortality. Rather, effects tend to manifest themselves through the following (see Hockin et al., 1992, Figure 1):

- behavioral changes (Bélanger and Bédard, 1989 and 1990);
- reduced pairing success (Habib et al., 2007);
- selection of alternative habitats that may be suboptimal (Béchet et al., 2003 and 2004);
- creating barriers to movement or decreasing available habitat (Bayne et al., 2005a and 2005b);
- decreases in foraging time (Burger 1994; Verhulst et al., 2001);
- reduced foraging efficiency;
- reduced time spent resting or preening (Tarr et al., 2010);
- prey switching;
- increases in energy expenditures due to flight behavior (versus resting, preening, or foraging) (Platteeuw and Henkens, 1997; Ackerman et al., 2004); and
- possible decreases in reproductive effort or nest success (Mainguy et al., 2002; McGowan and Simons, 2006).

Overall, the literature reviewed suggests negative short- and long-term disturbance effects to birds (Carney and Sydeman, 1999).

Noise, with particular reference to military aircraft as a disturbance factor, has been previously reviewed by Larkin et al. (1996), Gutzwiller and Hayden (1997), and Efroymson et al. (2000). Helicopters appear to exert a greater influence on avian behavior (flight initiation distance, duration in flight, and distance flown) than airplanes, likely due to the much higher decibel level associated with the prop wash (Ward et al., 1994 and 1999). Komenda-Zehnder et al. (2003, p. 10) recommended minimum flight altitudes (above sea level) of 450 m (1,476 ft) for helicopters and 300 m (984 ft) for airplanes based on results for disturbance to wintering waterbirds (mostly ducks). In the Gulf of Mexico, all aircraft are required to follow the Federal Aviation Administration's Advisory Circular 91-36C (1984) minimum altitude of 610 m (2,000 ft). This requirement is not tracked and it is likely that some of the helicopters departing from onshore sites to offshore platforms fly below the Federal Aviation Administration's minimum in areas of high bird density (e.g., waterbird colonies, beach-nesting bird colonies, and National Wildlife Refuges) to reduce total travel time or reduce fuel consumption, and during periods of inclement weather, high winds, or low ceilings. Although helicopter traffic in support of offshore oil and gas activities is anticipated to occur very frequently, i.e., 47-124 flights/day (**Tables 3-3, 3-6, and 3-14**; see the "Proposed Action Analysis" section below), in most cases, such disturbances tend to be relatively short in duration (**Figures 3-6, 3-7, and 4-24**).

Air Emissions

In North America, there is a dearth of information concerning potential impacts of air pollution on birds, other than effects related to acid rain (e.g., wood thrush in North America; Hames et al., 2002; see also Rimmer et al., 2005). In his review of air pollution impacts on wildlife, Newman (1979) stated that information was too limited to draw conclusions regarding species sensitivity.

Sources of air pollution on the OCS in support of routine activities include the following:

(1) service support vessels, i.e., boats, ships, etc.;

(2) helicopters;

(3) generators and other related gas- or diesel-powered engines on platforms;

(4) flaring; and

(5) other equipment on platforms (i.e., vents, fugitives, glycol dehydrators, pneumatic pumps, and pressure level controllers, boilers, heaters, and burners).

Wilson et al. (2010), in their Gulfwide inventory of emissions from platforms, documented a 19 percent increase (up over 9,000 tons since previous inventory) in VOC's, and the overall activity of flaring increased. For a more details regarding the list of OCS-related emission sources, the types of pollutants monitored, and total platform emission estimates, refer to Wilson et al. (2010, Table 8-1).

It is well known that the myriad constituents of air pollution (e.g., As, Cd, Se, H_2S, NO_x, CO, CO_2, CH_4, O_3 (ozone), Pb, Hg, MeHg, Fl, Al, SO_2, PAH's, chlorofluorocarbons, hydrochlorofluorocarbons, particulate matter [PM], and fly ash] may be harmful to wildlife (Newman and Schreiber, 1988; Schreiber and Newman, 1988) and humans. These and other pollutants are regulated by USEPA under the Clean Air Act of 1970 and subsequent provisions (Title 42, Chapter 85; refer to **Chapter 4.1.1.1.2 and Table 4-1**). However, not all air pollutants are regulated at levels that will necessarily prevent effects to all wildlife (Newman and Schreiber, 1988, pp. 385-386). Further, some areas of the country have existing emission standards that are above the standards promulgated to protect wildlife (Newman and Schreiber, 1988, p. 383). In general, effects of air pollution on wildlife including birds is poorly understood and poorly studied in the U.S. The combustion of fossil fuels and associated combustion products contribute significantly to air pollution in the U.S. and globally (Schmitt, 1998 and references therein).

Much of what we know regarding air pollution effects to birds is based on research outside of the U.S. Most studies outside the U.S. have been conducted in proximity to coal-fired power plants, copper smelters, or other factories in Belgium (Dauwe et al., 2004; Janssens et al., 2001), Spain (Llacuna et al., 1996), Finland (Eeva et al., 2000, 2003), and the Netherlands (Schilderman et al., 1997). Results from much of this research suggest that effects from air pollution may result in changes to local habitat, and prey abundance, distribution, and composition. This in turn can influence adult foraging behavior and success, ultimately resulting in declines to important reproductive parameters (i.e., clutch size, egg viability and hatching success, nestling growth, fledging success, etc.) for some species.

Recovery potential for a species or its ability to withstand additional population-level losses due to anthropogenic impacts (**Table 4-7**), including air pollution, is largely a function of its life-history strategy (Sæther and Bakke, 2000; Sæther et al. 2004; **Table 4-13 and Figure 4-19**). It is likely that birds using the CPA would encounter greater levels of air pollution than birds using the WPA due to (1) greater number of platforms and more flaring from platforms at a given point-in-time in the CPA than WPA, (2) greater number of total vessel trips in the CPA than WPA, and (3) greater number of helicopter support trips in the CPA than WPA (see the "Proposed Action Analysis" section below and **Tables 3-3 and 3-6**). Therefore, total air pollution associated with a CPA proposed action would likely be greater in the CPA than WPA (refer to **Table 4-1** for air quality standards; see also Wilson et al., 2010). This, of course, does not take into account between-area differences in prevailing winds, differences in associated infrastructure onshore, or other sources of inputs onshore. Regardless of the planning area (i.e., CPA or WPA), emissions generated by associated support vessels and helicopter traffic and the offshore platforms themselves is likely not trivial.

Produced Water

Produced water impacts on birds can vary from short term to long term and from sublethal to lethal (**Chapters 3.1.1.4 and 4.2.1.2.1.1.-4.2.1.2.1.4.**). Produced water has previously received limited attention relative to potential effects to birds using offshore waters or as a chronic source of pollution (Stephenson, 1997; Wiese et al., 2001). Analyses are based, in part, on the following assumptions:

(1) the regulatory limits established by USEPA eliminate or significantly reduce the potential for negative effects to most birds; and

(2) produced water and its constituent pollutants will be diluted simply as a function of the dilution potential of the ocean, minimizing potential harm to birds.

Produced water, including its constituent pollutants, is the largest waste stream associated with oil and gas production (Veil et al., 2004; Welch and Rychel, 2004; see also **Table 3-7**). The volume of produced water is not constant over time and increases over the life of an individual well (Veil et al., 2004). It has been estimated that U.S. wells produce 7 bbl of produced water for every barrel of oil and may comprise as much as 98 percent of the material brought to the surface for wells nearing the end of productivity (Veil et al., 2004). Produced water is comprised of a number of different substances including trace heavy metals, radionuclides, sulfates, treatment chemicals, produced solids, and hydrocarbons (see Veil et al., 2004, Table 2-1, for a complete list of substances and amounts from Gulf of Mexico wells). Pollutants discharged into navigable waters of the U.S. are regulated by USEPA under the Clean Water Act of 1972 and subsequent provisions (33 U.S.C. §1251 *et seq.*; **Chapter 3.1.1.4.2 and Table 3-7**). Specifically, an NPDES permit must be obtained from USEPA under Sections 301(h) and 403 (45 FR 65953, October 3, 1980) of the Clean Water Act. However, not all water pollutants are regulated or regulated at levels that will prevent effects to wildlife, including birds (Fraser et al., 2006, pp. 148-150).

Impacts to birds from pollutants remaining in produced water may be from ingestion or contact (direct) or from the changes in the abundance, distribution, or composition of preferred foods (indirect). O'Hara and Morandin (2010) documented measurable oil transfer to feathers and impacts to feather microstructure at sheen thickness as low as 0.1-0.3 micrometer. Even a light coating of hydrocarbons and other substances found in produced water can negatively affect feather microstructure, potentially compromising its buoyancy, insulation (i.e., thermoregulatory function and capacity), and flight characteristics (Stephenson, 1997; O'Hara and Morandin, 2010).

Marine Debris

Seabirds ingest plastic objects and other marine debris more frequently than do any other taxa (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. The effects of plastic ingestion may be long-term and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Moser and Lee, 1992; Pierce et al., 2004). The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Some birds also feed plastic debris to their young, which could reduce fledging success and offspring survival rates. As a result of stress from the consumption of debris, individuals may weaken, facilitating infection and disease; migratory species may then not have the energetic capacity to initiate migration or complete the migration process. The NTL 2012-BSEE-G01 was issued on January 1, 2012, and applies to all existing and future oil and gas operations in the Gulf of Mexico OCS.

Interactions with Structures and Associated Light

In discussing nocturnal circulation events, Russell (2005) noted that migrant species sometimes arrived at certain platforms shortly after nightfall and proceeded to circle those platforms for variable periods ranging from minutes to hours; 40 nocturnal circulation events were documented in spring 2000. It appears these nocturnal circulations occurred because the birds were attracted to platform light (in the form of flares and lighting) and tended to occur on overcast nights. Such circulations apparently were prevalent when birds got trapped inside the cone of light surrounding platforms, and birds seemed reluctant to leave the light to penetrate the "wall of darkness" (Russell, 2005; see also Montevecchi, 2006; Poot et al., 2008). Circulations put birds at risk for collision with platforms (Russell, 2005).

Annual mortality estimates for birds migrating across the GOM is roughly 200,000-321,000 (**Table 4-7**), which is mostly attributable to collisions. Trans-Gulf migrant bird collision mortality may be due to the fact that the presence of elevated platforms occurs in what was historically an otherwise featureless landscape (devoid of vertical structure), representing an evolutionarily recent phenomenon (barriers to movement; Bélisle and St. Clair, 2001). That is, birds have not had sufficient time to adapt to the presence of vertical structures above the sea surface in the Gulf of Mexico (Bevanger, 1994; Drewitt and Langston, 2008; Martin, 2011). For example, Pruett et al. (2009, p. 1,258) suggested that tall structures like power lines and wind towers placed in a prairie environment may have negative consequences due to habitat fragmentation effects and barriers to movement (dispersal) for lesser and greater prairie chicken populations because these species are adapted to an open, virtually tree-less landscape.

It is uncertain if this level of mortality has population-level effects for any of the species involved, but it is unlikely because of what is known of their life-history strategies (e.g., age at first reproduction, clutch size, nest success, etc.) (Arnold and Zink, 2011, p. 2). It should be noted that the level of mortality documented by Russell (2005) and described in **Table 4-7** represents a very small value or proportion compared with other sources of anthropogenic avian mortality, which are discussed in the cumulative impacts analysis.

Proposed Action Analysis

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, boats, and a variety of service vessels (**Tables 3-3 and 3-6**). It is projected that 35-67 production platforms would be installed in the CPA due to a CPA proposed action (**Table 3-3,** but see also **Table 3-6**). It is projected that 696,000-1,815,000 helicopter operations could occur from a CPA proposed action. This is a rate of 47-124 flights/day or 331-870 flights/week (**Chapter 3.1.1.8**). These numbers are in the range of 2.3-3 times greater than the proposed levels of helicopter operations in the WPA (**Figures 3-5 and 3-6**).

Vessel and Air Traffic: It is projected that 94,000-168,000 service-vessel round trips could occur from a CPA proposed action (**Table 3-3**, but see also **Table 3-6**). This is a rate of 6-11 vessel trips/day or 45-81 vessel trips/week. Again, these estimates for the CPA are roughly 1.4-2.3 times greater than service-vessel support estimates for the WPA. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and should adhere to regulations set forth by USCG for reduced vessel speeds within these inland areas (**Tables 3-14 and 3-15; Figures 4-24 and 4-28**). The effects would be limited to the immediate vicinity of the vessel and would be of short duration. Impacts to birds are expected to be adverse but not significant.

The Federal Aviation Administration and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft (213 m) while in transit offshore and 500 ft (152 m) while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft (305 m) over unpopulated areas or across coastlines and 2,000 ft (610 m) over populated areas and biologically sensitive areas such as National Wildlife Refuges and National Parks. Many relatively undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds (**Chapter 4.1.1.14.1 and Figures 4-12 through 4-14**). The effects are expected to be of short duration and limited in scope. Impacts to birds from helicopter flights associated with routine activities are expected to be adverse but not significant.

Overall, the predicted scenario statistics suggest a far greater number of exploration and production wells, more installed structures, far greater length of installed pipelines, and much higher level of support-related activities in the CPA (**Tables 3-3 and 3-6**) compared with the WPA (**Tables 3-2 and 3-5**; **Chapters 4.2.1.14.2 and 3.1.1.8**).

Air Pollution: **Chapters 3.1.1.5 and 4.2.1.1** provide an analysis of the routine effects of a CPA proposed action on air quality (see also above). Emissions of pollutants into the atmosphere from the activities associated with a CPA proposed action should result in minimal effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates (**Table 4-1**) and pollutant concentrations. The most likely pathway for air pollution to affect birds is through acidification of inland waterbodies and soils, and a subsequent change in trophic structure (White and Wilds, 1998;

USDOC, NOAA, 2011a). Even though the levels of activity are much greater in the CPA compared with the WPA, impacts to birds from decreased air quality due to routine activities are expected to be negligible because air quality impacts from a CPA proposed action are unlikely to impact ambient air quality (but see Wilson et al., 2010).

Produced Water: **Chapters 3.1.1.4 and 4.2.1.2** provide an analysis of the effects of a CPA proposed action on water quality (see also above). This discussion applies to both federally listed threatened or endangered avian species and nonlisted species. The degradation of coastal and estuarine water quality expected to result from of OCS-related discharges, particularly when added to existing degradation from other sources, may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources or habitat loss/degradation (Fraser et al., 2006). Operational discharges or runoff in the offshore environment (**Table 3-7 through 3-9**) could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms (Wiese et al., 2001; Burke et al., 2005). These impacts could also be both direct and indirect. Many seabirds feed and nest in the Gulf; therefore, water quality may also affect breeding success (measured as the ratio of fledged birds per nest to hatched birds per nest). Produced water is an operational discharge containing hydrocarbons, trace heavy metals, radionuclides, sulfates, treatment chemicals, and produced solids that represents most of the waste discharged from offshore oil extraction production facilities (Veil et al., 2004; Welch and Rychel, 2004). The NPDES permit maximum allowable oil and grease concentration is an average of 29 mg/L per month for the OCS and specifies a maximum (daily average) of 42mg/L daily, which are events that may cause sheens (Fraser et al., 2006, p. 149). However, the permittee is required to monitor free oil using the visual sheen test method on the surface of the receiving water. Monitoring is performed once per day when discharging, during conditions when observation of a sheen on the surface of the receiving water is possible in the vicinity of the discharge, and when the facility is manned. It is unlawful to discharge produced water that causes a visible sheen. Impacts to birds from produced-water discharges associated with routine activities are expected to be adverse but not significant.

Habitat Loss and Fragmentation: The analysis of the potential impacts to coastal environments (**Chapters 3.1.2.1 and 4.2.1.3**) concludes that a CPA proposed action is not expected to adversely alter barrier beach configurations greatly beyond existing, ongoing impacts in localized areas downdrift of artificially jettied and maintained channels. Adverse impacts of pipeline and navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands that may be used by many species of birds. Initial impacts are locally significant and largely limited to where OCS-related canals and channels pass through wetlands. For a CPA proposed action, 0-1 new pipeline landfalls and 0-1 new gas processing plants are projected per lease sale (**Tables 3-13 and 3-16**).

Trash and Debris: Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris, specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal. This discussion applies to both federally listed threatened or endangered avian species and nonlisted species. It is believed that coastal and marine birds are less likely to become entangled in or ingest OCS-related trash and debris due to BSEE regulations that prohibit the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.300). Also, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters (effective January 1, 1989, and enforced by USCG). As such, impacts to birds from OCS-related trash and debris associated with routine activities are expected to be negligible.

Interaction with Structures and Associated Lights: Each spring, migratory landbirds, most of which are passerines, cross the Gulf of Mexico from wintering grounds in Latin America to breeding grounds north of the Gulf of Mexico. A similar reverse migration occurs again in the fall. Some birds use offshore platforms as stopover sites for this migration, and some birds also are attracted to the structures' lights and become engaged in nocturnal circulations at the structures.

It is well understood by the scientific community that the pre-departure body condition for most neotropical migrants is likely approaching some optimal threshold prior to departure (at staging areas before crossing the Gulf). Therefore, time spent engaged in nocturnal circulations likely uses a considerable amount of energy, thereby reducing the probability of successfully completing the migration (Hutto, 2000; Parrish, 2000). Also, most of the birds "resting" on platforms represent individuals in poor body condition that may not have completed the migration. The loss of these individuals represents a natural source of mortality. That is, these individuals were probably below the population mean level (correcting for sex-age differences) of body reserves (fat stores) necessary to complete the migration (Moore and Yong, 1991; Moore et al., 1995; Yong and Moore, 1997).

Thus, circulation events and stopovers at platforms represent migration delays, and such delays almost certainly result in fitness costs to individuals involved (in nocturnal circulations or using platforms as stopover sites). Any perceived benefits to trans-Gulf migrants would likely only be realized by the several species of migrating raptors (see Russell, 2005, Table 6.3) for several reasons:

(1) an abundance of available raptor perch sites;

(2) raptor prey is superabundant;

(3) raptor prey are available in an open environment, increasing capture success; and

(4) raptor prey available represent individuals that are weak, starving, or dead, thereby increasing individual foraging efficiency and energy uptake compared with the pursuit of healthy prey in more challenging habitats. For most other species, they would historically be expected to migrate without stopovers and the ability to find food or prey sources en route is unreliable at best, thus indicating most impacts from circulation events would be negative.

During the fall of 1999, Russell (2005) observed 273 peregrine falcons on 10 platforms, and these falcons took 389 prey items representing 69 species of birds. Peregrine falcons, at least, benefit from the presence of offshore platforms.

Adverse, but not significant, impacts to birds are expected as a result of structure emplacements and light interactions associated with the routine activities of a CPA proposed action.

Summary and Conclusion

In general, the effects from routine activities in the CPA (**Tables 3-3, 3-4, 3-6, 3-22, and 3-23**) are expected to exceed those in the WPA due to differences in the number of proposed (and current) platforms, onshore infrastructure and pipeline landfalls, and the number of service support vessel and helicopter trips (refer to **Chapter 4.1.1.14.2** for a comparison). The majority of the effects resulting from routine activities of a CPA proposed action on threatened or endangered and nonthreatened and nonendangered coastal and marine birds are expected to be sublethal, e.g., primarily disturbance-related effects (but see discussion above and **Chapter 4.2.1.16.2**). However, as has been documented by Russell (2005), collision-related mortality of trans-Gulf migrant landbirds does occur; approximately 50 birds/platform or roughly 200,000 birds/year across the archipelago. Conservatively, the addition of 35-67 installed platforms would probably result in the collision death of an additional 1,750-3,350 birds/year or 70,000-134,000 over the life of newly installed platforms (**Table 4-7**). Over the life of the GOM platform archipelago (a 40-year period), mortality estimates may be on the order of 7-12 million birds (**Table 4-7**). This represents an adverse, but not significant, impact to coastal and marine birds. These estimates should be considered conservative given that (1) they only include deaths due to collisions and (2) these estimates do not account for issues related to detection bias. Although there will always be some level of incomplete information on the effects from routine activities under a CPA proposed action on birds, there is credible scientific information, applied using acceptable scientific methodologies, to support the conclusion that any realized impacts would be generally sublethal in nature and not in themselves rise to the level of reasonably foreseeable significant adverse (population-level) effects. Also, routine activities will be ongoing in the proposed action area (CPA) as a result of active leases and related activities. (In the CPA, there are 4,377 active leases as of May 2012). Within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that routine activities from the preexisting OCS Program are significantly impacting bird populations. Therefore, a full understanding of any incomplete or unavailable information on the effects of routine activities is not essential to make a reasoned choice among the alternatives. Particularly when compared with other causes of bird mortality, the routine events associated with the OCS Program are unlikely to result in population-level impacts to avian species.

Overall, impacts to avian species from routine activities are expected to be adverse but not significant. The impacts include the following:

- temporary behavioral changes, temporary or permanent changes in habitat use, temporary changes in foraging behavior, temporary changes to preferred foods or prey switching, temporary or permanent emigration, temporary or permanent reductions in nesting, hatching, and fledging success;
- sublethal, chronic effects due to exposure to or intake of OCS-related contaminants via spilled oil, pollutants in the water from service vessels, produced water, or discarded debris;
- nocturnal circulation around platforms may create acute sublethal stress from energy loss and the addition of platforms will increase collision risk;
- minimal habitat impacts (based on actual acres of footprint) are expected (onshore or within State waters) to occur directly from routine activities resulting from a CPA proposed action (but see Johnston et al., 2009); and
- secondary impacts from pipeline and navigation canals to coastal habitats will occur over the long term and may ultimately displace species to other habitats, if available.

Presently, there are no mitigations (or stipulations) in place specific for the protection and conservation of migratory birds (USDOI, 2009). However, avoidance measures and conditions are routinely placed on permitted activities to protect habitat. One possible avoidance measure available is the use of lights with less red and more green in the spectrum. Such actions tend to reduce avian nocturnal circulation (frequency and duration of events). At this time, the lighting of platforms and OCS structures is regulated by several Federal agencies (including the USCG and the Federal Aviation Administration).

4.2.1.16.3. Impacts of Accidental Events

The impacts of accidental events associated with a CPA proposed action on all marine and coastal birds are expected to be adverse, but not significant, in the absence of a catastrophic spill similar to the DWH event. The following analysis includes information developed and incorporated in the wake of the DWH event (Oil Spill Commission, 2011b). Additional information on oil-spill impacts to birds and results from avian monitoring related to the DWH event can be found in **Chapter 4.2.1.16.1**. A more detailed discussion of catastrophic oil-spill events can be found in **Appendix B**. Oil-spill occurrence, probabilities, and volumes for the Gulf of Mexico can be found in **Tables 3-11, 3-12, 3-17, 3-18, and 3-22**. A summary (last updated May 12, 2011) of birds collected by FWS (USDOI, FWS, 2011b) as part of the post-spill monitoring and collection process can be found in **Table 4-8**. A comparison of the DWH event relative to a representative sample of other major oil spills worldwide and estimated avian mortality associated with each spill is provided in **Table 4-15**.

Hurricane-related impacts are discussed in **Chapter 4.2.1.16.1** and included direct impacts to avian populations, habitats, and food resources. The USCG (USDHS, CG, 2006) reported six major, five medium, and 5,000 minor oil spills resulting in roughly 214,285.7 bbl (9 million gallons) of oil spilled into the Gulf of Mexico in the wake of Hurricanes Katrina and Rita (**Tables 3-25 and 3-26**).

These results and the reviews from the Oil Spill Commission (2011d, 2011e, and 2011h) suggest that oil-spill probabilities and estimates of spill size and frequency may be biased low. Or at a minimum, impacts to infrastructure from hurricanes should also be considered as a variable when attempting to model oil spill-related parameters and associated risk (Stewart and Leschine, 1986; Pulsipher et al., 1998; Kaiser and Pulsipher, 2007). The BOEM has run a new OSRA catastrophic spill analysis, which is available in **Appendix C**.

Due to the aging infrastructure, particularly pipelines, spill-related risks or probabilities may not be constant over the life of a CPA proposed action, especially in the event of hurricanes (**Table 3-26 and Figure 3-5**).

Background/Introduction

This section discusses impacts to coastal and marine birds resulting from accidents associated with a CPA proposed action. Impact-producing factors include oil spills regardless of size and oil-spill cleanup activities, including the release of rehabilitated birds. Impact discussions are combined for the two general groups of birds: (1) threatened or endangered birds (**Table 4-14**), and (2) nonthreatened or nonendangered avian species because the impact-producing factors considered are the same regardless of conservation status. As previously mentioned in **Chapters 4.2.1.16.1 and 4.2.1.16.2**, it is recognized that, due to either the small initial population size, the initial population trajectory, or both for threatened and endangered avian species, any spill and associated cleanup activities would likely have a proportionately greater negative effect to the population (Dennis et al., 1991; Belovsky et al., 1994). With the DWH event, Congress and various Federal commissions have indicated potential interest in holding parties involved in accidental events that impact migratory birds responsible under the Migratory Bird Treaty Act (Alexander, 2010; Corn and Copeland, 2010).

Oil spills represent the greatest potential direct and indirect impact to coastal and marine bird populations. Birds that are heavily oiled succumb to acute toxicity effects shortly after exposure (Clark, 1984; Leighton, 1993). If the physical oiling of individuals or local flocks of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigable waterways can contact and affect the different groups of coastal and marine birds, most commonly seabirds, divers, marsh and wading birds, waterfowl, and some species of shorebirds (King and Sanger, 1979, Table 1; Williams et al., 1995, Table 5; Camphuysen, 2006, Table 6) (**Tables 4-8 and 4-12**).

Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Birds that are heavily oiled usually die. Lighter PAH's like napthlalene and phenanthrene are volatile and water-soluble, but they are somewhat more persistent compared with lighter, more volatile, and more water-soluble hydrocarbons like benzene (Albers, 2006). Even low levels of oil may have multiple deleterious effects, including the following:

- changes in behavior;
- interference with feeding drive and food detection;
- alteration of food preferences and ability to discriminate between poor versus ideal food items;
- predator detection and avoidance;
- definition and defense of breeding and feeding territories;
- kin recognition;
- weakening of pair bonds (Butler et al., 1988);
- changes in incubation behavior (Butler et al., 1988; Fry et al., 1986);
- reduced provisioning of nestlings and fledglings leading to reduced growth and survival (Trivelpiece et al., 1984; Boersma et al., 1988); and
- alteration of homing ability and fidelity for highly philopatric species.

Residual material that remains after evaporation and solubilization are water-in-oil emulsions (mousse), which are the primary pollutant onshore after oil from offshore spills actually reaches land. The mixing of mousse and sediments form aggregates that have the odor of oil and, after photo- and biological oxidation, form asphaltic "tarballs" and pavements (Briggs et al., 1996). Mousse emulsions may be the most toxic petroleum component because they are the most hydrophobic and will penetrate the hydrophobic core of the plasma membrane of cells and will cause disruption of the membrane and enter the cells as well (Briggs et al., 1996 and 1997). Common symptoms of exposed birds include dehydration, gastrointestinal problems, infections, arthritis, pneumonia, hemolytic anemias, cloacal impaction, and eye irritation. Therefore, antibiotic treatments, nutritional support, rehydration, and other protocols are used at rehabilitation centers (Briggs et al., 1996 and 1997).

When oil gets into vegetated or unvegetated sediment, low redox potentials, absence of light, and waterlogged substrate may result in oil that can neither be oxidized by bacteria and sunlight nor evaporate. The oil may also remain in its unweathered toxic state indefinitely. However, weathering-related effects on the oil from its path offshore towards the coast should ameliorate, to some extent, toxicity at the shoreline.

The use of feeding areas at the sea surface and intertidal wetland zone, where spilled oil tends to accumulate, makes the waterbirds, shorebirds, and some species of seabirds vulnerable to exposure to oil (**Tables 4-8 and 4-12**; see also Dunnet, 1982) (**Figure 3-10**; see also the "Proposed Action Analysis" below). If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected (Burger and Fry, 1993; Leighton, 1993). Affected individuals may initially appear healthy, but they may be affected by physiological stress that does not occur until much later. Biochemical impacts of lighter PAH's have not been extensively described, but they may include increased susceptibility to physiological disorders including disruption of homeostasis, weakened immune systems and reduced resistance to disease, and disruption of respiratory functions (Briggs et al., 1996).

Under natural conditions, water does not penetrate through the vanes of the feathers because air is present in the tiny pores in the lattice structure of the feather vane. Oil, with its reduced surface tension, and hydrophobic characteristics, adheres to keratin and mats the feather barbules into clumps; the lattice opens up (breaks down) and water penetrates and displaces insulating air (Lambert et al., 1982; O'Hara and Morandin, 2010). Oil also mats the feathers together, displacing insulating properties of trapped air (Jenssen, 1994). Dispersants also reduce water surface tension in the feather lattice pores (they have a surfactant component) and render them water-attracting instead of water-repelling (Stephenson 1997; Stephenson and Andrews, 1997). Thus, at a certain surface tension, water will penetrate the feathers, and death from reduced thermoregulatory function may result (Lambert et al., 1982; Stephenson, 1997; Stephenson and Andrews, 1997). Birds that must feed on or in the water will lose heat faster than semi-aquatic birds (e.g., wading- and shorebirds) that can feed with dry plumage on land (Jenssen, 1994).

Ingestion of oil by birds affects reproductive ability (Velando et al., 2005a and 2005b; Zabala et al., 2010). It may reduce eggshell thickness, resulting in eggs being cracked by incubating adults. Alonso-Alvarez et al. (2007a and 2007b) used blood chemistry of yellow-legged gulls (*Larus michahellis*) to compare long-term sublethal toxicity of the *Prestige* oil spill with short-term experimental sublethal toxicity in captive birds fed small amounts of fuel oil. Long-term effects were measured about 19 months after the spill. Short-term effects were measured in captive birds fed a small amount of fuel oil for 7 days. Adults from oiled colonies and fuel-oil-fed experimental birds had higher total PAH's and lower levels of three natural metabolites. Calcium was lower in oil-fed females than in control females, but it was the same in oil-fed and control males. Calcium is critically important to females during follicular development as it is used for production of the egg shell.

Ingestion of oil may alter liver enzyme function, osmoregulatory function, adrenocortical processes, and corticosteroid levels, and it may cause anemia (Lambert et al., 1982; Rocke et al., 1984; Pérez et al., 2010). Burger (1997) reported that exposure to small amounts of oil reduces immune response to diseases or results in decreases in body mass such that impacts may not be documented for many years or until oiled birds face additional environmental stressors. At which time, exposed birds tend to experience higher levels of mortality compared with unexposed birds.

External oiling of eggs can slow embryonic growth, induce tumor growth, reduce gas conductance through the eggshell, and decrease hatchability (Jenssen, 1994). Impacts on vital life-history characteristics such as growth rates (Szaro et al., 1978a and 1978b; Trivelpiece et al., 1984) or reproductive parameters such as reproductive success can occur, resulting in possible local population extinction. Indirect effects occur by fouling of nesting habitat and by displacement of individuals, breeding pairs, or populations to less favorable habitats; changes in preferred prey abundance and distribution have also been documented (Esler et al., 2002; Golet et al., 2002; Velando et al., 2005b). Competition from con- and heterospecifics may prevent displaced birds from accessing and occupying unoiled or undisturbed habitats, particularly for seabird colonies in southeastern Louisiana.

Sometimes, because of a lack of thorough training of all personnel or the sheer scale of operations, the air, vehicle, and foot traffic that takes place during shoreline cleanup may disturb nesting populations and degrade or destroy habitat.

In general, research on long-term survival and reproduction of rehabilitated, oiled birds is limited, and in general, results to date are mixed (Anderson et al., 1996; Sharp, 1996; Anderson et al., 2000; but see Golightly et al., 2002; Mazet et al., 2002; Underhill et al., 2005). Success of rehabilitation for oiled birds may be a function of capture and handling methods, overall oiling and exposure of the individual, facility design, and availability of food, water, and space while in captivity, as well as species-specific characteristics including body size, metabolism, and resting-heart-rate. It is critical that rehabilitated birds remain disease-free while in captivity. A major concern for holding wild animals, including birds, in facilities post-spill is the potential to expose the wild population to diseases once rehabilitated individuals are released. In some cases, the loss from disease could equal or exceed losses due to oil contamination. The efficacy of rehabilitation of birds after an oil spill remains a contentious and unresolved issue among avian ecologists and the scientific community alike (Estes, 1998; Jessup and Mazet, 1999).

Timing (i.e., if peak periods in bird density overlap temporally with the spill; Fraser et al., 2006), location (high versus low bird density area), wind conditions, wave action, and distance to the shore may have a greater overall effect on bird mortality than spill volume and fluid type (Wilhelm et al., 2007; Castège et al., 2007; Byrd et al., 2009). The *Exxon Valdez* spilled only about 10.8 million gallons but it killed about 100,000-300,000 birds (Piatt et al., 1990a and 1990b; Piatt and Ford, 1996). The sea state at the time of the *Exxon Valdez* accident was relatively calm, and the oil was heavy, high-viscosity crude, resulting in little capability for chemical treatment or natural dispersal, breakdown, and weathering. Because of its undispersed state, the *Exxon Valdez* oil principally affected surface-dwelling and shore-dwelling organisms such as birds. As oil weathered, the exposure of seabirds to oil from the *Exxon Valdez* spill shifted from direct oiling to ingestion of oil with prey or of contaminated prey (Piatt and Anderson, 1996; Seiser et al., 2000; Golet et al., 2002; Esler et al., 2010; but see also Wiens et al., 2001b; 2004). For a long-term review of the ecosystem following the *Exxon Valdez* spill, refer to Peterson et al. (2003).

Long-term impacts of the *Sea Empress* spill (22.1 million gallons of crude or twice the size of the *Exxon Valdez*) in Wales was considered moderate. Ten years post-spill, common scoter numbers in the area were similar to pre-spill (Banks et al., 2008). Banks et al. (2008, pp. 898-901) did document impacts to the wintering population of common scoters from the spill but suggested that the primary effect was a change in habitat use and distribution; numbers recovered within surveyed areas 2-3 years later. For additional information, see **Chapters 4.2.1.16.1 and 4.2.1.16.2** (**Tables 4-8, 4-12, and 4-13**).

Short- and long-term responses by birds to an oil spill are likely to be species-specific and may be a function of the species' life-history and its habitat use and diet (see Piatt et al., 1990a; Burger and Fry, 1993; Votier et al., 2005). If for a given avian species, its preferred habitat and food resource are also impacted by a spill, the species will be forced to locate and settle in alternative habitats, modify its foraging behavior, or select alternative food resources. Conversely, fidelity to the impacted area could result in reduced energy uptake via reduced food availability, reduced foraging success, prey switching, or residual sublethal toxicity effects that may negatively impact body condition and survival (e.g., after the *Exxon Valdez*, harlequin ducks [Esler et al., 2000b and 2002] and pigeon guillemots [Seiser et al., 2000; Golet et al., 2002]).

No peer-reviewed studies of the impacts of oil spills on birds in the Gulf of Mexico, including impacts of cleanup activities associated with the spill from the DWH event and long-term impacts on forage food supplies for birds, are now publicly available and nonconfidential. This information is being developed through the NRDA process, which may take many years, and most of the information NRDA has collected to date is not publicly available at this time. This section on accidental impacts concerns a CPA proposed action only; the DWH event is discussed in relation to bird baseline conditions in the description of the affected environment for birds. The BOEM acknowledges that this information may be essential to a reasoned choice among alternatives, but it is not possible for BOEM to obtain this information in the timeline envisioned for this EIS. As there is a process ongoing that may take years, given the realities of the DWH event, cost is not a relevant factor in BOEM's ability to obtain this information. The BOEM has applied what additional scientifically credible information is available using accepted scientific methodologies, as described above. In place of Gulf-specific studies, investigations of spills in other areas, mathematical modeling, and laboratory tests (e.g., toxicity tests and veterinarian studies of rehabilitation) are used for insight into potential DWH impacts on all life-history stages of birds.

Proposed Action Analysis

Representative species of the seven bird groups, except for the whooping crane, are widely distributed across the Gulf (**Tables 4-9 through 4-11 and Table 4-14**); therefore, an oil spill, depending on its size and distribution, would likely affect only a small fraction of a given species' population (but see **Tables**

4-12 and 4-13 and figures below). The combined probabilities varied greatly depending on duration (10 days versus 30 days) and the avian species group considered. The probabilities of oil spills occurring and contacting coastal bird habitat in the CPA at 10- and 30-day probabilities, respectively, as the result of a CPA proposed action over its 40-year life are as follows (**Figures 3-10 and 3-14 through 3-21, and Chapter 3.2.1.8**):

- 11-20 percent and 20-34 percent for diving birds (**Figure 3-18**);
- 11-19 percent and 20-34 percent for gulls and terns (**Figure 3-16**);
- 7-13 percent and 14-2 percent % for shorebirds (**Figure 3-17**);
- 1-2 percent and 4-8 percent for passerines (**Figure 3-21**);
- <0.5-1 percent and 1-2 percent for marsh and wading birds (**Figure 3-19**);
- 10-18 percent and 17-30 percent for waterfowl (**Figure 3-20**);
- 1-3 percent and 6-11 percent for raptors (**Figure 3-15**); and
- 4-8 percent and 8-14 percent for the threatened piping plover (**Figure 3-14**);
- year-round probabilities for western Louisiana are 10-8 percent and 14-25 percent;
- year-round probabilities for Texas are 3-5 percent and 9-16 percent;
- year-round probabilities for Mississippi are <0.5-1percent;
- year-round probabilities for Alabama are <0.5-1percent;
- year-round probabilities for Florida Panhandle are <0.5 percent and 1-2 percent; and
- year-round probabilities for Florida (west) are <0.5 percent and 0.5 percent.

In all cases, however, probability estimates greatly exceeded estimates for the WPA. The OSRA does not take into account (1) species-specific densities, (2) spatial and temporal patterns in avian distribution, (3) species-specific habitat preferences, (4) relative vulnerabilities to oiling (**Tables 4-8 and 4-12**), or (4) species-specific life-history or demography (**Figures 4-18 and 4-19**). For additional information on the Oil Spill Risk Analysis considered here, see **Chapters 3.2.1.4-3.2.1.6.**

Small coastal spills, pipeline spills, and spills from accidents in navigable waterways (**Tables 3-23 and 3-39**) can contact and differentially affect the seven avian species groups of coastal and marine birds (**Tables 4-8 and 4-12**). **Table 4-12** provides relative oiling ranks for the seven avian species' groups considered herein (oiling rate, sample size in parentheses): diving birds (27%, n = 136); seabirds (34%, n = 5,309); waterfowl (33%, n = 52); marsh-wading birds (26%, n = 378); passerines (19%, n = 73); shorebirds (18%, n = 81); and raptors (4%, n = 17). These numbers are almost certainly biased low for a myriad of reasons (Castège et al., 2007; Byrd et al., 2009, Flint et al., 2010).

In the CPA, an estimated total of 967-1,885 spills (spill size range = 0-1.0 bbl to ≥1,000 bbl) could occur as a result of a CPA proposed action (**Table 3-12**). Over the 40-year life of the OCS Program, the mean number of predicted spills is 17.89-23.87 (≥1,000 bbl) and 4.91-6.65 (≥10,000 bbl), respectively **(Tables 3-19 and 3-20).** The probability or percent chance of a single oil spill (≥1,000 bbl) occurring in the CPA by resource estimate (low; high) are facilities (10%; 18%), pipelines (27%; 35%), and total (31%; 37%) (**Table 3-22**). The probability of a pipeline spill (n = 1) occurring is roughly 1.9-2.7 times higher than that for facilities (**Table 3-22**). In the CPA, data from **Table 3-23** suggest that platforms accounted for 39.5 percent of spills versus just 0.2 percent for pipelines (1996-2009). Overall, the cumulative total of all spills (regardless of size) estimated to occur in the CPA (**Table 3-22**) is roughly 3.9-4.5 times higher than the number of estimated spills in the WPA (**Tables 3-21**). From 1996-2009, there were 12,956 spills in the CPA (**Table 3-23**). In comparison, there were 931 spills in the WPA (**Table 3-23**); 13.9 times more spills in the CPA (**Table 3-23**). Overall, the cumulative total of all spills estimated to occur in the CPA (regardless of size) ranges from 967 to 1,885, roughly 3.95-4.48 times higher than the number of estimated spills in the WPA (**Table 3-12**).

The DWH event and resulting oil spill in Mississippi Canyon Block 252 impacted birds that came into contact with oil, primarily in the CPA (**Table 4-8 and Figures 4-15 and 4-16**). As of May 12, 2011, 104 avian species totaling 7,258 individuals had been collected (**Table 4-8 and Figure 4-17**). Many species impacted by the DWH event breed outside the GOM, but the timing of the DWH event largely overlapped peak breeding period for many regional species (**Tables 4-9 through 4-11**) (USDOI, FWS, 2011b). In addition, cleanup and monitoring efforts related to the DWH event may have dramatically reduced reproductive success for numerous species using coastal, island, beach, and marsh habitats due to the large number of personnel, aircraft, boats, ATV's, etc. and the temporal overlap of these efforts with peak nesting (National Audubon Society, Inc., 2010; USDOI, FWS, 2011b). Impacts from cleanup crews on nesting birds were probably reduced on National Wildlife Refuge lands and State-managed Wildlife Management Areas because access was restricted or limited until after the nesting season. Though there are some data available regarding effects on birds in the impact area, there remains a large amount of uncertainty regarding total avian mortality and population-level impacts (**Tables 4-12 and 4-13; Figures 21 and 22**). Based on a species' recovery potential (**Table 4-13**), it is probable that populations of the northern gannet, greater shearwater, common loon, least tern (the nonfederally listed population of local breeders), brown pelican, and royal tern were the most severely impacted.

For additional information regarding potential impacts to avian resources in the offshore environment, refer to the DWH event discussion in **Chapter 4.2.1.16.1.** Uncertainty and separating confounding effects from actual impacts to avian populations associated with the DWH event will be challenging (Stewart-Oaten and Bence, 2001; Parker and Wiens, 2005). This was certainly the case for avian research and monitoring conducted in the wake of the *Exxon Valdez* oil spill, and the disparate interpretations of the science were born out in the literature (e.g., Wiens, 1996; Piatt, 1997). There remains incomplete and unavailable information on the effects to coastal and marine birds from the DWH event (and thus changes to the avian baseline in the affected environment and impacts from future accidental events). The BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to coastal and marine birds. The BOEM believes that this incomplete or unavailable information regarding effects of the DWH event on birds may be essential to a reasoned choice among alternatives, particularly for species listed as endangered or threatened. Relevant data on the status of bird populations after the DWH event may take years to acquire and analyze through the NRDA process, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted scientific methodologies and approaches.

In the absence of a catastrophic spill, impacts of a CPA proposed action on all coastal birds are expected to be adverse, but not significant, because of the number and relatively small size of spills expected over the 40 year life of a proposed action. Depending on the size of the spill, location, time of year, duration, and magnitude of associated oil-spill cleanup efforts, associated activities may impact or further exacerbate coastal bird issues regardless of personnel training and experience (National Audubon Society, Inc., 2010).

Summary and Conclusion

Overall, impacts to coastal and marine birds associated with accidental events (oil spills regardless of size) in the CPA should be greater compared with the WPA due to the following factors: greater number of platforms; higher oil-spill probabilities; and greater numbers of predicted oil spills, particularly pipeline spills, over the life of a CPA proposed action (**Tables 3-3, 3-4, 3-6, 3-12, and 3-22**). In addition, avian species diversity, abundance, and density for numerous species of beach-nesting waterbirds and coastal marshbirds appear to be greater in the CPA than in the WPA (**Chapter 4.2.1.16.1**; Hunter et al., 2002 and 2006; USDOI, FWS, 2010a).

Oil spills (and disturbance impacts associated with clean up) have the greatest impact on coastal and marine birds. Depending on the timing and location of the spill, even small spills can result in major avian mortality events (see Piatt et al., 1990a and 1990b; Castège et al., 2007; Wilhelm et al., 2007). Small amounts of oil can affect birds, and mortality from oil spills is often related to numerous symptoms of toxicity (Burger and Gochfeld, 2001; Albers, 2006). Data from actual spills strongly suggest that impacts to a bird species' food supply are typically delayed after initial impacts from direct oiling (e.g., Esler et al., 2002; Velando et al., 2005b; Zabala et al., 2010). Sublethal, long-term effects of oil on birds have previously been documented (Esler et al., 2000b; Alonso-Alvarez et al., 2007a), including changes to sexual signaling (Pérez et al., 2010).

Oil-spill impacts on birds from a CPA proposed action are expected to be adverse, but not significant, given the number and relatively small size of spills expected over the 40-year life of a CPA proposed action. Impacts of oil-spill cleanup from a CPA proposed action are also expected to be adverse, but not significant, but may be negligible depending on the scope and scale of efforts. In the event of a catastrophic spill, depending on the timing, location, and size of the spill, could result in significant impacts to coastal and marine birds. For additional information on catastrophic spill, refer to **Appendix B**.

4.2.1.16.4. Cumulative Impacts

A detailed impact analysis of the coastal and marine birds for a CPA proposed action can be found in **Chapters 4.2.1.16.1-4.2.1.16.3**. The following is a summary of new information that has become available since the DWH event (Oil Spill Commission, 2011b). Additional information on oil-spill impacts to birds and results from avian monitoring related to the DWH event can be found in **Chapter 4.2.1.16.1** (see also **Tables 4-8 and 4-12 through 4-15**) (USDOI, FWS, 2011b). The incremental contribution of a CPA proposed action to the cumulative impact is considered adverse but not significant.

A more detailed discussion of catastrophic oil-spill events can be found in **Appendix B**. Information regarding a CPA proposed action and associated activity levels and oil-spill information can be found in **Tables 3-3, 3-6, 3-11, 3-12, 3-18, and 3-22**. More detailed information regarding procedures, policies, reviews from case law, challenges associated with cumulative impacts assessment in NEPA documents, and influence on the decisionmaking process can be found in Burris and Canter (1997), NRC (2005a), Smith (2006), and Benson (2009).

One of the most comprehensive studies to date on cumulative effects of human development on wildlife was conducted by Johnson et al., (2005). Bolze and Lee (1989) provide a review of potential impacts of offshore oil and gas development on Arctic wildlife. More recently, Copeland et al. (2009), Schultz (2010), and Johnson and St. Laurent (2011) provide thorough reviews regarding cumulative impacts of development (e.g., oil and gas, mining) on wildlife.

Background/Introduction

This cumulative analysis considers impact-producing factors (refer also to CEQ, 1997; Pierce, 2011) that may adversely affect populations of threatened and endangered avian species (**Table 4-14**), as well as nonthreatened and nonendangered species related to OCS and non-OCS activities (**Tables 4-8, and 4-11 through 4-13**). For simplicity sake, both listed and nonlisted avian species are considered together, although it is recognized that potential impacts from OCS activities may have relatively greater overall negative effects to listed species than nonthreatened and nonendangered species (**Chapter 4.2.1.16.1 and Table 4-14**).

The OCS activities include the following:

- a CPA proposed action; and
- prior and future OCS sales.

The non-OCS activities include the following:

- State oil and gas activity;
- crude oil imports by tankers; and
- other commercial, military, and recreational offshore and coastal activities.

The OCS-related, impact-producing factors include the following:

- air pollution;
- pollution of coastal and offshore waters resulting from OCS-related activities including platform and pipeline oil spills, produced waters, and any spill-response activities;
- structure presence and lighting;
- aircraft and vessel traffic and associated noise and disturbance impacts, including OCS helicopter and service-vessels;
- habitat loss, alteration, and fragmentation resulting from coastal facility construction and development;
- OCS pipeline landfalls; and
- trash and debris.

The non-OCS, impact-producing factors include the following:

- air pollution;
- pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge;
- tanker oil spills and spills related to oil and gas activities in State coastal waters and any spill-response activities;
- aircraft and military activities, including jet training overflights and sonic booms;
- nonconsumptive recreation, including bird-watching activities, ATV use, walking and jogging with pets, and other beach use;
- maintenance and use of navigation waterways;
- habitat loss, alteration, and fragmentation associated with commercial and residential development;
- collisions of coastal and marine birds with various anthropogenic structures (e.g., buildings, power lines, cell phone towers, etc.);
- diseases;
- climate change and related impacts;
- storms and floods;
- coastal development; and
- fisheries interactions.

Proposed Action Analysis

OCS-Related and Non-OCS-Related Air Pollutants

Air pollutants include the amount of sulfur dioxide (and other regulated pollutants; see **Table 4-1 and Chapters 4.1.1.1.1-4.1.1.1.4**) expected to be released due to a CPA proposed action, as well as from prior and future OCS sales, and State oil and gas activity. These pollutants may adversely affect coastal and marine birds and their habitats (**Chapter 4.1.1.14.2**). Pollutant emissions into the atmosphere from the activities under the cumulative analysis are expected to have minimal effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations, as regulated by USEPA (but see Wilson et al., 2010, Tables 8-1 and 8-2).

Emissions of pollutants into the atmosphere under the cumulative analysis are projected to have minimal effects on onshore air quality because of the atmospheric regime, emission rates (**Table 4-1**), and the distance of these emissions from the coastline. Onshore impacts to air quality from emissions under the OCS cumulative analysis are expected to be within both Class I and Class II PSD allowable increments, as applied to the respective subareas. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} under the cumulative analysis are estimated to be less than Class I and Class II PSD allowable increments for the respective subareas as per both the steady-state and plume dispersion analyses, and they are assumed to be below concentrations that could harm coastal and marine birds (but see **Chapter 4.1.1.14.2**; see also Newman, 1979; Newman and Schreiber, 1988).

Although direct impacts (i.e., mortality) on coastal and marine birds due to air quality under the cumulative analysis are expected to be minimal, indirect impacts may include chronic, sublethal effects including reduced egg viability and hatchability, smaller overall clutch sizes, reduced fledging body mass, and overall fledging success, leading to overall reduced recruitment (refer to Eeva et al., 1997, 2003, and 2005). These effects could be the result of impacts to a birds' habitat or food supply rather than on individual birds, per se. If habitat and food resources are negatively impacted by air pollutants during the pre-laying period, it could influence energy devoted to the clutch. At the same time, these same effects could manifest themselves by reduced provisioning rates by adults to nestlings/fledglings or by provisioning at similar rates, but with different food resources, i.e., prey switching (the alternative prey has less per capita energy).

Although the incremental contributions of offshore emissions are below or within those allowed by USEPA, it is uncertain to what extent the contributions from OCS-related activities to the overall production of air pollutants on an annual or cumulative basis (refer to Wilson et al., 2010, Tables 8-1 and 8-2) could adversely impact avian populations in the GOM region. Nevertheless, these impacts would not be expected to rise to population-level impacts across the GOM.

OCS-Related Impacts

Degradation of Water Quality

Water quality (**Chapters 4.2.1.2.1.1-4.2.1.2.2.4 and Tables 3-7, 3-8, 3-9, and 3-23**) of coastal environments will be affected by bilge water from service vessels and point- and nonpoint source discharges from supporting infrastructure (refer to Veil et al., 2004, Table 2-1, for a complete list of substances and amounts from Gulf of Mexico wells). Water quality in marine waters will be impacted by the discharges from drilling, production, and platform removal operations (Veil et al., 2004; Welch and Rychel, 2004; Fraser et al., 2006). Degradation of coastal and inshore water quality resulting from factors related to a CPA proposed action, plus those related to prior and future OCS sales; crude oil imports by tankers; and other commercial, military, and recreational offshore and coastal activities is expected to adversely impact coastal and marine birds (**Chapter 4.1.1.16.2**; see also Fraser et al., 2006).

In 2008, USEPA (2008b) rated the overall condition of the waters in the Gulf of Mexico at 2.2 (on a scale from 1 to 5 with 5 being highest), one of the lowest scores of any region in the U.S. The NOAA (USDOC, NOAA, 2011a, Figure 54) noted that almost half of the 37 major estuarine systems in the Gulf of Mexico were considered moderately polluted. Further, 14 percent of all Superfund sites nationwide that have been cleaned up or remediated occur in the Gulf Coast region (USDOC, NOAA, 2011a, p. 40); 99 of 189 (52%) counties and parishes in Texas, Louisiana, Alabama, Mississippi, and Florida are coastal. Not included during USEPA's monitoring program (USEPA, 2008b) were waters in the hypoxia zone (O_2 depleted water) found on the Gulf of Mexico continental shelf adjacent to the outflows of the both the Mississippi and Atchafalaya Rivers (Rabalais et al., 2002a). This area is well known and represents the second largest coastal zone of hypoxia in the world (Rabalais et al., 2001 and 2002b). Thus, the waters of the Gulf Coast region are some of the most contaminated in all of the U.S. The incremental addition related to a CPA proposed action would contribute to further degradation of water quality, but this remains a small addition when compared with all other natural and anthropogenic sources.

Platform and Pipeline Oil Spills and Any Improperly Directed Spill-Response Activities

Oil spills have the greatest potential to impact coastal and marine birds (**Tables 4-8, 4-12, and 4-13;** see also **Tables 3-11, 3-12, 3-17, 3-18, and 3-22**). Use of waterbird, marshbird, shorebird, and seabird feeding areas at the sea surface and at the intertidal wetland zone, where spilled oil may accumulate, makes many avian species extremely vulnerable to spilled oil (**Tables 4-8, 4-11, and 4-13**). Exposure to small amounts of oil may result in long-term, sublethal, chronic impacts on birds with the potential to impact food resources through changes in distribution and abundance, i.e., availability of preferred foods (e.g., Esler et al., 2002). Mortality from oil spills is often related to numerous symptoms of toxicity. Including all spill sizes (range 0-1.0 bbl to ≥1,000 bbl) and both facilities and pipelines, it is estimated that 967-1,885 spills could occur due to a CPA proposed action (**Table 3-12**). For facilities, there is a 10-18 percent probability of a ≥1,000 bbl spill as a result of a CPA proposed action (**Table 3-22**). For pipelines, there is a 27-35 percent probability of a ≥1,000 bbl spill as a result of a CPA proposed action (**Table 3-22**). Pipelines are roughly 2 times more likely to produce ≥1,000 bbl spills compared with facilities. From 2001 through 2009, the annual number of spills (all sources, OCS and non-OCS) ranged from 454 to 1,728 spills, and spill volume ranged from 212 to 44,141 bbl, with a median spill size of 1,560 bbl (**Table 3-11**).

The extensive oil and gas industry operating in the Gulf area may have caused low-level, chronic, petroleum contamination of coastal waters (**Tables 3-11, 3-17, 3-18, and 3-23**; see also Holdway, 2002; Jernelöv, 2010). Outside of a catastrophic event, petroleum spills or releases that result from a CPA proposed action or OCS energy program would be expected to be small, particularly when compared with naturally occurring seeps in the GOM (**Chapter 3.1.1.7.1**). Nevertheless, lethal effects are expected primarily from uncontained, inshore oil spills and associated, spill-response activities in wetlands, and other biologically sensitive coastal habitats (National Audubon Society, Inc., 2010; USDOI, FWS, 2010a). Primary physical effects are from the oiling itself and the ingestion of oil during preening, with secondary effects through ingestion of contaminated prey (Wiens et al., 1984; Piatt et al., 1990a; Burger and Fry, 1993). Recruitment of birds and a population's recovery from a major mortality event may take many years, depending upon the species and its life-history strategy (**Table 4-13 and Figures 4-18 and 4-19**).

Oil-spill impacts on birds from a CPA proposed action are expected to be adverse but not significant. This conclusion takes into account the much greater number of proposed platforms, landfalls, service vessel and helicopter trips, higher oil-spill probabilities, etc., compared with the WPA.

Structure Lights and Presence

Every spring, migratory landbirds, including neotropical passerines, cross the Gulf of Mexico from wintering grounds in Latin America to breeding grounds north of the Gulf of Mexico. The reverse migration is repeated again in the fall. Migrants sometimes arrive at platforms shortly after night fall or later and proceed to circle those platforms (referred to as nocturnal circulation event) for variable periods ranging from minutes to hours (Russell, 2005). Nocturnal circulation events around platforms may create lethal effects from collisions with platforms (**Table 4-7**; see footnote 5), acute sublethal stress from energy loss, and increased predation risks. Data supporting the premise that platforms represent suitable stopover habitat for migratory birds is equivocal (**Chapter 4.1.1.16.2**.; see also Russell, 2005, p. 247). Presently, it is unknown if birds participating in nocturnal circulation events actually have sufficient energy reserves post-event to successfully complete their migration. It is estimated that collisions with platforms in the GOM leads to annual mortality of 200,000-321,000 birds (**Table 4-7**; see footnote 5). Conservatively, the proposed action may increase the level of mortality by 1,750-3,350 birds/yr or 70,000-134,000 over the life of newly installed platforms. Over the life of the entire platform archipelago a range of 7.6-12.2 million birds may be killed, primarily due to collisions (**Table 4-7**). Changes to the lighting type and/or intensity may decrease the attraction to platforms and collision risk associated with well-lit platforms for migrating birds (Wiese et al., 2001; Montevecchi, 2006).

It is uncertain if this level of mortality has population-level effects for any of the species involved, but it appears unlikely because of what is known of their life history strategies (e.g., age at first reproduction, clutch size, nest success, etc.) (Arnold and Zink, 2011, p. 2). This does not negate the fact that this represents an additional source of anthropogenic mortality, and is therefore, included here.

Though presently there are no mitigations in place to address circulation events and attraction of birds to platforms and associated collision risk, BOEM has recently proposed a study to determine if changes to present lighting systems on platforms might reduce associated avian mortality (Poot et al., 2008). The Max Planck Institute for Ornithology in Germany has conducted experimental research that strongly suggests it is the red component of the light that affects birds the most, and it has an impact on their internal compass causing them to fly in circles until they either collide with something or fall to the ground (or sea) exhausted. This research resulted in the development of a new lighting system that has very little red light in the spectrum (slightly green). This new lighting system was installed along-side the traditional lighting system, and when the lights were switched from the traditional to the new system, the circling birds reoriented their flight pattern and flew away from the platform (Poot et al., 2008 and colleagues). The new lighting system dramatically reduced the number of collision-related mortalities at the platform. If Federal agencies with jurisdiction over OCS structural lighting allow for it and if new platforms are designed to utilize this new lighting system and existing platforms convert to green lights, this should reduce or mitigate the number of avian collisions in the GOM.

Aircraft and Vessel Traffic and Noise from Helicopters and Service Vessels

Helicopter and service-vessel traffic related to OCS activities would likely disturb feeding, resting, and nesting behavior of birds (at least temporarily), and it may also cause temporary or permanent abandonment of nests, nestlings, fledglings, and emigration from or avoidance of disturbed, preferred habitat (see Burke et al., 2005). The Federal Aviation Administration (Advisory Circular 91-36C) and corporate helicopter policy states that helicopters must maintain a minimum altitude of 700 ft (213 m) while in transit offshore and 500 ft (152 m) while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft (305 m) over unpopulated areas or across coastlines and 2,000 ft (610 m) ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. The net effect of OCS-related flights on coastal and marine birds is expected to result in temporary, often sporadic disturbances, which may result in displacement of localized flocks. During nesting periods, this could ultimately result in some reproductive failure from nest abandonment or depredation of eggs and young in the absence of a disturbed adult.

Service vessels are expected to use selected nearshore and coastal (inland) navigation waterways, and they are further expected to adhere to guidelines established by USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways may reduce the disturbance effects from service vessels on nearshore and inland populations of coastal and marine birds. However, to date, efficacy of these measures has not been quantified. It is expected that service-vessel traffic may routinely disturb some populations of coastal and marine birds occurring within these areas.

It is estimated that the effects of both OCS and non-OCS vessel traffic on birds within coastal areas are substantial.

For a more detailed discussion of disturbance-related impacts, see **Chapter 4.2.1.16.2**. It is anticipated that both service-vessel traffic and helicopter flights in support of OCS activities in the CPA would be far greater than in the WPA. Therefore, disturbance-related impacts to avian populations should be relatively greater in the CPA than in the WPA.

Habitat Loss, Alteration, and Fragmentation Resulting from Coastal Facility Construction and Development

Under the cumulative activities scenario, factors contributing to coastal landloss or modification include the construction of 0-1 gas processing plants for a CPA proposed action, as well as other associated roads, pads, and facilities (**Tables 3-13, 3-15, and 3-16**; **Figures 3-5, 3-6, and 3-7**). Though the realized footprints of this construction tends to be relatively small based on an acreage basis, the associated disturbance from vehicular traffic, human presence, and noise likely increase the overall impact area (Habib et al., 2007; Bayne et al., 2008; Bayne and Dale, 2011). Lawson et al. (2011) documented an increase in wintering grassland bird abundance with increasing distance from development-related access roads at Padre Island National Seashore, Texas. However, the authors did not document any differences in bird abundance when comparing among sites; active wells, active pumping stations, abandoned well sites, and roads (Lawson et al., 2011, Figure 2). The contribution of development from urban and other industrial growth will be substantial, causing both the permanent loss of habitat (both on land and wetlands) and increased levels of disturbance associated with new construction and facilities. Though the information pertains primarily to onshore, breeding birds, the review by Bayne and Dale (2011) provides a detailed discussion regarding potential effects of energy development on songbirds.

Habitat loss and fragmentation remain the largest threats to avian diversity and abundance in the U.S. and worldwide (Gaston et al., 2003; Barrow et al., 2005; Lepczyk et al., 2008). Cumulative activities related to a CPA proposed action will likely contribute to further loss, alteration, and fragmentation of avian habitat although certainly at a much smaller spatial scale than non-OCS private and commercial construction and development activities (White and Wilds, 1998).

Pipeline Landfalls

Under the cumulative activities scenario, factors contributing to coastal landloss or modification include construction of 0-1 pipeline landfalls for a proposed action. From 1996 through 2009, there were 12 OCS-related pipeline landfalls in Louisiana and Texas (**Table 3-16 and Figure 3-5**). For a typical lease sale in the CPA, it is estimated that 628-1,870 km (390-1,162 mi) of pipeline would be used, not including the length of pipelines installed in State waters (**Table 3-3**). The estimated length (25,204-57,177 km; 15,661-35,528 mi) of installed pipeline related to OCS activities is dramatically higher over the 40 year life in the CPA (**Table 3-6**). Adverse impacts of pipeline canals are the most significant OCS-related and proposed-action-related impacts to wetlands (**Figures 3-5 and 3-7**).

For a detailed review of impacts of OCS-related pipelines and navigation canals on wetland habitats, refer to Ko and Day (2004a and 2004b) and Morton et al. (2006). Initial impacts are locally significant and largely limited to where OCS-related canals pass through wetlands (Johnston et al., 2009). Wetlands are one of the most ecologically diverse and economically important habitats in the Gulf region providing a host of benefits to the regions' fish and wildlife resources (USDOC, NOAA, 2011a).

See **Chapters 4.2.1.4.1-4.2.1.4.4** for more details regarding impacts to wetlands; see also reviews by Gosselink et al. (1998). Dahl (2006) estimated an annual loss rate of 5,540 ac (2.242 ha) for the intertidal estuarine and marine wetland class, mostly in Louisiana, from all impacting factors. He stated that several factors may have contributed to wetland losses between 1998 and 2004, including deficiency in sediment deposition, canals and artificially created waterways, wave-related erosion, land subsidence, and saltwater intrusion.

Trash and Debris

Coastal and marine birds may experience chronic physiological stress from sublethal exposure to or intake of contaminants or discarded debris associated with OCS-related activities. This may result in disturbances to and displacement of single birds or in some cases entire flocks. Chronic sublethal stress is often a challenge to detect in birds, and more importantly, to directly link to a given environmental stressor independent of other environmental factors (Wiens et al., 2001b; Parker and Wiens, 2005). Sublethal stresses may weaken individuals (especially serious for migratory species), making them more susceptible to infection, disease, and parasites. Recruitment of birds and a population's recovery from a major mortality event may take many years, depending upon the species and its life-history strategy (**Table 4-13 and Figures 4-18 and 4-19**).

Much of the floating material discarded from vessels and structures offshore presumably drifts ashore, remains within coastal waters, or eventually sinks. These materials may include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest overall damage to birds (**Table 4-7**; see also Tasker et al., 2000; Dau et al., 2009; Ryan et al., 2009). Coastal and marine birds are commonly entangled in discarded trash and debris (Robards et al., 1995). Many species will readily ingest small plastic debris, either intentionally or incidental to consuming prey. Interaction with plastic materials may lead to debilitating injuries or even death (Pierce et al., 2004).

It is believed that coastal and marine birds are less likely to become entangled in or ingest OCS-related trash and debris as a result of BSEE regulations regarding the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.300 and NTL 2012-BSEE-G01). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of any plastics at sea or in coastal waters (effective January 1, 1989). To date, the efficacy of these regulations on reducing seabird mortality has not been quantified. Despite these regulations, unknown quantities of plastics and other materials are discarded and lost in the marine environment, and so remain a threat to individual birds (Azzarello and Van Vleet, 1987).

Overall, the cumulative impacts from discarded materials related to the CPA should be minimal but relatively greater than that in the WPA.

Non-OCS Related Impacts

Habitat Loss, Alteration, and Fragmentation Associated with Commercial and Residential Development

Habitat loss and fragmentation has the potential to affect all aspects of an avian community's annual life cycle and the overall population size for some species of birds that occur in the Gulf of Mexico (Arlt and Pärt, 2007). Vital habitat needs to be conserved and protected so that the ecosystem maintains its structure and function relative to birds and their associated requisite resource needs (Newton, 1998). Unfortunately, in many areas the highly fragmented landscape (Perlut et al., 2008a and 2008b) makes it extremely difficult for avian species to persist, e.g., farmed landscapes in the Midwest and associated declining populations of grassland-dependent avian species (Murphy, 2003; Peterjohn, 2003; Brennan and Kuvlesky, 2005). Many ecosystems of the United States have been dramatically altered, and in some cases lost, post-European settlement (Noss et al., 1995). Additional cumulative activities will continue to stress individuals and their populations, causing them to avoid or emigrate from traditional breeding, feeding, or wintering areas or alter migratory routes. Some of the species may be declining (**Table 4-14**) and are further being displaced from areas along the coast (and elsewhere) as a result of the destruction of or encroachment on their preferred habitat(s) (Andrén, 1994; Withers, 2002). As these birds emigrate to and settle in undisturbed areas of similar habitat (assuming it is available), their presence may increase intra- and interspecific competition for space and food (Goss-Custard, 1980).

Avian habitat loss, alteration, and fragmentation associated with commercial and residential development is almost certainly occurring at a much faster pace and on a spatial scale far exceeding that compared with OCS activities. Birds are adaptable with ephemeral settling patterns, but the pace with which they can adapt may be too slow compared with the pace with which anthropogenic habitat loss, alteration, or fragmentation is occurring across the U.S. (and Canada). This appears to be resulting in some species of breeding birds making poor "choices" (i.e., selecting habitats that negatively affect survival or fecundity; "sinks" or "traps"), at least in the short term (Clark and Shutler, 1999; Kristan, 2003; Battin, 2004). Delayed responses to habitat loss by some avian species are likely to occur when the rate of habitat loss or modification and/or environmental perturbation (e.g., climate change) exceeds the demographic potential of the population decoupling population dynamics from landscape dynamics (With et al., 2008).

See **Chapters 4.2.1.4.1-4.2.1.4.4** for more details regarding impacts to wetlands. Dahl (2006) estimated an annual loss rate of 5,540 ac (2,242 ha) for the intertidal estuarine and marine wetland class, mostly in Louisiana, from all impacting factors. He stated that several factors may have contributed to wetland losses between 1998 and 2004, including deficiency in sediment deposition, canals and artificially created waterways, wave-related erosion, land subsidence, and saltwater intrusion.

Tanker Oil Spills and Spills Related to Oil and Gas Activities in Coastal State Waters and Spill-Response Activities

Most offshore non-OCS-related spills occur from vessel and barge operations (Helm et al., 2008; **Tables 3-8, 3-9, and 3-11**). Based on the OSRA model for coastal spills ≥1,000 bbl, the estimated total number of spills is 3 per 6 years for the total of non-OCS sources; for offshore spills ≥1,000 bbl, the estimated total number of spills for non-OCS sources is ≤1 per year for tank ships and ≤1 per year for tank barges. In summary, the use of waterbird, marshbird, shorebird, and seabird feeding areas at the sea surface and at the intertidal wetland zone, where spilled oil tends to accumulate, makes many avian species extremely vulnerable to spilled oil (**Tables 4-8, 4-12, and 4-13**). Exposure to small amounts of oil may have delayed impacts on birds (O'Hara and Morandin, 2010) as well as to their food resources (Velando et al., 2005b; Zabala et al., 2010). Mortality from oil spills is often related to numerous symptoms of toxicity. Oil spills in the cumulative case have the greatest potential impact to coastal and marine birds (e.g., **Tables 4-8 and 4-15**; see also USDHS, CG, 2006; USDOC, NOAA, 2010l).

Oil-spill-related impacts on birds from the total cumulative scenario are expected to range from moderate to adverse, but not significant, in the absence of another major spill (i.e., DWH; Oil Spill Commission, 2011b). The incremental increase of oil spills from a CPA proposed action to the total cumulative impacts is also expected to be adverse, but not significant.

Pollution of Coastal Waters Resulting from Municipal, Industrial, and Agricultural Runoff and Discharge

Non-OCS-related activities and natural processes that can impact marine water quality include bilge water discharges from large ships and tankers, and coastal pollutants that are transported away from shore, including runoff, river input, sewerage discharges, industrial discharge, and natural seepage of oil and gas. There exists a wide variety of contaminant inputs into coastal waters bordering the Gulf of Mexico (USEPA, 2008b; USDOC, NOAA, 2011a). Contaminants from non-OCS pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge may have acute or chronic, lethal, or sublethal impacts to avian populations in the GOM. The dominant pollution source is the large volume of water from the Mississippi River, which drains over two-thirds of the contiguous United States, creating a zone of hypoxia offshore at the continental shelf (Rabalais et al., 2001, 2002a, and 2002b). Major activities that have added to the contamination of Gulf coastal waters include the petrochemical industry, agriculture, forestry, urban expansion, extensive dredging operations, municipal sewerage treatment processes, marinas and recreational boating, maritime shipping, and hydromodification activities (Schmitt, 1998; White and Wilds, 1998). Additional significant sources of water pollutants include large, commercial waste disposal operations, livestock farming, manufacturing industry activities, power plant operations, and pulp and paper mills. Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. All of these factors, as well as sedimentation, greatly contribute to the diminishing water quality in the GOM and associated rivers and wetlands within the southeastern United States (USEPA, 2008b; USDOC, NOAA, 2011a).

Aircraft and Military Activities Including Jet Training Overflights and Sonic Booms

Noise, with particular reference to military aircraft as a disturbance factor, has been reviewed by Gladwin et al. (1988), Manci et al. (1988), and Larkin et al. (1996). Helicopters appear to exert a greater influence on avian behavior (flight initiation distance, duration in flight, and distance flown) than airplanes likely due to the much higher decibel level associated with the prop wash (Komenda-Zehnder et al., 2003, Figure 5; Rojek et al., 2007). Ward et al. (1999) documented species-specific differences in behavior and disturbance distances for Pacific brant and Canada geese staging at Izembek Lagoon in coastal Alaska. Further, the authors recommended that all aircraft follow not only the Federal Aviation Administration's (1984) minimum altitude of 610 m (2,000 ft) but also adopt a lateral buffer distance of 1.6 km (~1 mi). Disturbance effects (e.g., air and vessel traffic) can have variable impacts to avian populations depending on the type, intensity, duration, distance to and frequency of the disturbance, as well as due to species-specific differences in tolerance levels (Blumstein, 2006; Blumstein et al., 2005; Wright et al., 2010). Disturbance-related impacts typically result in behavioral changes, selection of alternative habitats that may be suboptimal, disturbance resulting in barriers to movement or decreasing available habitat, decreases in foraging time, reduced foraging efficiency, prey switching, increases in energy expenditures due to flight behavior (versus resting, preening, or foraging), and possible decreases in reproductive effort or nest success (Béchet et al., 2004; Francis et al., 2009; Tarr et al., 2010). In some cases, habituation, temporary displacement, or simple changes in avian behavior have been documented (Conomy et al., 1998a and 1998b). Based on results for disturbance to wintering waterbirds (mostly ducks), Komenda-Zehnder et al. (2003) recommended minimum flight altitudes (above sea level) of 450 m (1,476 ft) for helicopters and 300 m (984 ft) for airplanes.

In the CPA, disturbance impacts from the large volume of helicopter traffic and service vessels (**Tables 3-3, 3-6, 3-13**; **Figures 4-18 and 4-19**) represent incremental increases to the total cumulative scenario. Impacts to affected avian populations are expected to range from negligible to adverse, but not significant (**Chapters 4.2.1.16.1-4.2.1.16.3**).

Nonconsumptive Recreation

Impacts of nonconsumptive recreation depend on many factors, including species and type of recreation and associated disturbance. Even visitation by those most interested in conserving wildlife may result in detrimental effects (Klein 1993; Bouton et al., 2005). Visiting nesting areas can generate interest in and funding for avian conservation and research efforts, but the associated disturbance can cause birds to abandon the very areas that wildlife managers are trying to protect (Burger and Gochfeld, 1998; Fernández-Juricic et al., 2004). Most studies of the effects of visitors on waterbirds did not identify mechanisms or levels of impact, determine relative effects of different kinds of disturbance, or control for confounding influences (Carney and Sydeman, 1999). Overall, however, the evidence to date suggests negative short- and long-term disturbance effects to birds. Additional information on disturbance effects to birds can be found in reviews by Smit and Visser (1993) and Platteeuw and Henkens (1997).

Energy cost in birds is highest for flight. Flight in response to disturbance will result in increased energy requirements and feeding time, and increased flight time will reduce the total time for other activities (Ely et al., 1999; Ackerman et al., 2004). Fleeing from disturbance may affect feeding behavior and the effects of predation in complex ways; staying put may increase or decrease fitness. Outdoor recreation, especially nonconsumptive uses like bird watching, is expanding into refuges and is putting additional stresses on wild populations (Klein et al., 1995; Schummer and Eddleman, 2003). Ecotourists (including bird watchers and wildlife photographers) and outdoor recreationists are not likely to be aware of the negative impacts that their presence may have on wildlife (Carney and Sydeman, 1999). Ecotourists can introduce high levels of disturbance to nesting waterbird colonies (Rodgers and Schwikert, 2002 and 2003). Ecotourists often closely approach birds, return to the same sites repeatedly, and visit sites year-round. Predation risk and its proxy (response to human disturbance) can impact reproduction via decisions about parental investment (Frid and Dill, 2002). Once parents have considerably invested in their offspring, they may protect their investment by increasing nest attentiveness during incubation (and the provisioning period for some species) after a severe disturbance, but they may abandon the site the following year (Steidl and Powell, 2006).

Recreational vessel traffic is assumed to be a much greater source of impact to birds in coastal habitats. These vessels are, in most cases, required to comply with strict speed/wake restrictions (small recreational fishing boats, ski boats, etc.), but often do not adhere to these restrictions and therefore flush coastal and marine birds from feeding, resting, and nesting areas (Larsen and Laubeck, 2005). Such disturbances displace local flocks from their preferred habitats and could lead to abandonment of the areas in general or could result in partial or complete reproductive failure (Rodgers and Smith, 1995; Rodgers and Schwikert, 2003). Disturbance may also result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity.

For additional discussion on the topic, see **Chapter 4.2.1.16.1**.

Maintenance and Use of Navigation Waterways

Adverse impacts related to construction of navigation canals for oil and gas development in State waters and on the OCS have generated substantial impacts to coastal wetlands (Ko and Day, 2004a; Morton et al., 2006; Day et al., 2007; **Figures 3-5 and 3-7**). Initial impacts are locally substantial but largely limited to where canals and channels pass through wetlands. Current channels should not be altered dramatically as a result of a CPA proposed action. In addition, no new channels would be required for a CPA proposed action. Periodic maintenance dredging is necessary and expected in existing OCS-related navigation channels through barrier passes and associated bars (Johnston et al., 2009). Much of the impacts from oil and gas development on coastal wetlands have already occurred. The continued long-term effects of saltwater intrusion, wind and wave action from storms, and erosion from wave action created by oil- and gas-related traffic and recreational/commercial fishermen continue to take their toll on coastal salt marshes and associated wildlife and fisheries communities in the Gulf Coast region (Gosselink et al., 1998). From 1998 through 2004, wetland losses from all causes for all coastal wetland types was estimated at 442,200 ac (178,952 ha) (Stedman and Dahl, 2008; Engle, 2011, Table 1).

Besides the economic and social benefits related to the recreational and commercial fisheries and hunting, coastal wetlands also provide such ecosystem services as storm surge protection, nitrogen and other contaminant filtration or removal, carbon sequestration, and benefits as habitat for myriad species of fish and wildlife (Gosselink et al., 1998; Engle, 2011).

Collisions of Coastal and Marine Birds with Various Anthropogenic Structures

Wide-scale, long-term, standardized, and systematic assessments of bird collisions with manmade structures are limited (**Table 4-7**; see also Erickson et al., 2001). The most important structural features related to collision risk may be size (overall dimensions) or height and lighting; intensity and color associated with a given structure (Bevanger, 1994 and 1998). No hypotheses for the apparent attraction of birds, especially nocturnally migrating songbirds, to lights have been conclusively supported (Drewitt and Langston, 2008; but see Martin, 2011). The placement of elevated structures either along migration corridors, along ridgetops, on top of hills, and at cliff edges appear to be particularly problematic for birds, resulting in increased collision risk and collision-related mortality (e.g., wind turbines at Altamont Pass, California [Smallwood and Thelander, 2008; Smallwood et al., 2009]). Warning lights for aircraft on towers >200 ft (61 m) are mandatory in the United States (Drewitt and Langston, 2008). Birds that avoid collision with windows may become exhausted while fluttering against windows, possibly in response to their reflection, that of surrounding habitat, or due to the invisible nature of the glass whereby birds detect habitat on the opposite side of the structure; some become stressed and fall to the ground (Drewitt and Langston, 2008; Klem, 2009) where they are vulnerable to predation (e.g., housecats-Dauphiné and Cooper, 2009). Overall mortality caused by collision with tall buildings is considerable (Drewitt and Langston, 2008). Window strikes may be the greatest cause of anthropogenic mortality in the United States (**Table 4-7**), at least an order of magnitude greater than strikes with wind turbines, communication towers, tall buildings, and power lines (excluding distribution lines to residences and businesses) (Klem, 2009; Manville, 2005a and 2009). Collisions with power lines and supporting towers can occur during inclement weather and during periods of migration, often causing death or permanent injury to birds (Gehring et al., 2009 and 2011). By 2000, the estimated annual avian mortality from collision with communication towers was at least 4-5 million birds, but it may be closer to 40-50 million (Manville, 2005a). Combining collision mortality estimates for communication towers, power lines, and window strikes the total mortality may be approaching 1 billion birds killed annually (Manville, 2005a and 2009; Klem, 2009). Drewitt and Langston (2008) suggested that, for some avian species, mortality >0.5 percent may have serious population-level impacts (but see Arnold and Zink, 2011, p. 2).

Though not mentioned in the section heading, housecats have become an increasingly devastating introduced predator in many ecological systems throughout the world. In fact, in the U.S. alone, estimates based on the number of housecats multiplied by average annual bird mortality per cat results in estimates of 468 million to 8.4 billion birds killed (Dauphiné and Cooper, 2009 and 2011; **Table 4-7**). The lower range would place housecat mortality second only behind collisions with windows/buildings (Klem, 2009), whereas if the upper range even remotely approximates reality, then housecat-related mortality would far exceed all other anthropogenic sources of avian mortality.

See **Chapter 4.2.1.16.2 and Table 4-7** for more detailed information regarding the impacts of platforms on migratory birds.

Diseases

Throughout North America, avian mortality associated with diseases, broadly defined here to include lead poisoning, probably results in the death of millions of birds annually (**Table 4-7**). Although lead poisoning represents an anthropogenic source, it is still considered and described by Friend and Franson (1999) in the *Field Manual of Wildlife Diseases*. Though the authors describe in detail the various types of diseases, signs in the field, handling procedures, submitting specimens, etc., little information is provided regarding estimated annual mortality of birds. Friend and Franson (1999) list seven broad classes of primarily avian diseases, under each are varying numbers or kinds of specific diseases: bacterial (e.g., avian cholera); fungal (e.g., aspergillosis); viral (e.g., duck plague, avian influenza); parasitic (e.g., coccidiosis and sarcosystis); biotoxins (e.g., avian botulism); chemical toxins (e.g., lead and oil); and miscellaneous (e.g., ingestion of plastic particles). In the U.S., the most commonly diagnosed bacterial bird diseases tend to be avian cholera, chlamydiosis, and salmonellosis. The most commonly diagnosed viral diseases were duck plague, paramyxovirus, and West Nile virus, together causing almost all deaths due to infectious diseases; fungal and parasitical infections were relatively minor (Newman et al., 2007). As part of the captive-rearing program procedures, captive-reared whooping cranes have been vaccinated with a DNA vaccine for the RNA West Nile virus; the vaccine offers temporary relief but interferes with the natural selection for immune resistance (Kilpatrick et al., 2007).

The impact of influenza viruses on wild animal host survival, reproduction, and behavior are almost completely unknown (Vandegrift et al., 2010). The two most important groups of migratory birds that are natural reservoirs for influenza viruses are waterfowl and charadriiformes (including shorebirds and gulls) (Vandegrift et al., 2010). LaDeau et al. (2007) stated that "Emerging infectious diseases present a formidable challenge to the conservation of native species in the twenty-first century." The number of diagnosed bird deaths was greater for viruses than for bacterial infections (Newman et al., 2007).

Though the level of mortality associated with most diseases (excluding lead poisoning; see **Table 4-7**) is unknown, avian death due to various diseases is likely in the millions annually. In some cases, diseases like West Nile virus has been implicated as a population-limiting factor for the already declining sage grouse (Naugle et al., 2004 and 2005). Avian diseases may become an increasingly important mortality factor to consider, particularly since increasingly more habitat is being lost, altered, or fragmented; environmental contaminants are prevalent in many ecosystems; and in some cases, avian populations may be occurring at densities promoting the spread of diseases. Many diseases are more easily spread amongst individuals at high densities, e.g., molting waterfowl and botulism.

Climate Change and Related Impacts

In general, climate change as it relates to migratory birds may impact certain species in a myriad of ways (Crick, 2004). Effects may manifest themselves through relatively "simple" range contractions or expansions, either elevationally or latitudinally (Sekercioglu et al., 2008). Fundamentally, impacts from either of these situations should be similar, depending on the species involved. As an example, some species may expand their range farther up a mountainside, while others may be further restricted to shrinking habitats (at or near the snowline) due to their preference for cooler environments and associated habitat. MacLean et al. (2008) documented a northeastward shift in the centroids for several species of waders (*Charadrii*) sampled from roughly 3,500 sites over a 30-year period in western Europe.

The relatively recent overlap of previously spatially segregated (or segregated by microhabitat features) species may increase interspecific competition for resources, which may lead to changes in species composition and abundance (Martin, 2001). In some cases where long-term data are available, results unequivocally demonstrate phenological changes like earlier nesting (Møller et al., 2008). Interestingly, these same authors documented declines in species that had not changed the timing of nesting in response to changing environmental conditions (Møller et al., 2008). It is possible that species that cannot adapt relatively rapidly could incur temporal mismatches (Visser et al., 1998 and 2004). This could be particularly problematic for long-distance migrants (e.g., numerous species of shorebirds) that winter south of the equator but that breed in the Arctic. Timing of departure from the wintering grounds tends to be optimized such that peak arrival and/or peak hatching overlaps the peak in food resource availability (Piersma and Lindström, 2004; Both et al., 2009; Saino et al., 2011).

Predictions for models of waterfowl adapted to the dynamic nature of the Prairie Pothole Region seem particularly dire, with major contractions (shrinking wetland and grassland habitat base) to their breeding range and likely population declines for many species (Sorenson et al., 1998; Johnson et al., 2010; Withey and van Kooten, 2011).

Possibly more relevant to both breeding and wintering species along the northern GOM is the impacts from predicted sea-level rise on the availability and distribution of preferred habitats. Many species of birds are closely linked to shallow-water habitats, primarily for food resources (e.g., marshbirds, waterbirds, shorebirds; **Tables 4-8 and 4-11**). Numerous species (e.g., brown pelican, terns, and plovers) typically use beaches, mudflats, dunes, bars, barrier islands, and similar nearshore habitats for nesting (Hunter et al., 2002 and 2006; USDOI, FWS, 2010a). Sea-level rise is expected to inundate much of the low-lying areas and also increase water depths in areas farther inland, resulting in major losses to preferred nesting and foraging habitats for many species of coastal birds (Galbraith et al., 2002; Erwin et al., 2006; MacLean et al., 2008). As the sea-level rises, impacts from storm surges and flooding will extend farther inland, exacerbating habitat losses for many avian species (see Dolman and Sutherland, 1995; West and Caldow, 2006).

For additional information on the topic of climate change impacts to birds, and in an ecological and evolutionary context, respectively, refer to Møller et al. (2004) and Parmesan (2006).

Storms and Floods

Coastal storms and hurricanes can often result in the direct mortality of many species of birds, but likely the larger impact is to the habitat on which the populations rely. Associated storm surges and flooding can destroy active nests and force birds into suboptimal habitats. Nesting territories and colonial waterbird and marshbird rookeries with optimum food and/or nest-building materials may also be destroyed. Species reliant on the beaches, islands, gravel bars, spoil-piles, and other coastal low-lying structure for nesting are particularly vulnerable to habitat loss or alteration associated with such storms (USDOI, FWS, 2010a). Elevated levels of municipal, industrial, and agricultural pollutants in coastal wetlands and waters will probably expose greater numbers of resident breeding birds and wintering migrants to chronic physiological stress due to these contaminants being redistributed across the landscape as a result of storms and flooding (Burger and Gochfeld, 2001).

Hurricane-related impacts to birds are provided in more detail in **Chapter 4.2.1.16.1**.

Coastal Development

The construction of buildings and other facilities is expected to continue to encroach on bird habitat along the coastline in the northern Gulf of Mexico (Visser et al., 2005; LeDee et al., 2008). Areal extent of the proportion of habitat lost may increase as a linear function with ecological consequences to birds, and in general, negative effects of habitat loss tend to outweigh effects from fragmentation (Fahrig, 1997). The presence of habitat thresholds depends on the characteristics of species' habitat requirements and attributes of the landscape (With et al., 2008; Fahrig, 1998 and 2002). As mentioned previously, if habitat loss (and fragmentation) occur at a pace that exceeds adaptation, then various species of birds reliant on these coastal habitats during some part of their annual life cycle will be forced to disperse to alternate habitats (assuming they are available), or their populations will likely decline (With and Crist, 1995; Chalfoun and Martin, 2007). Also, habitat loss and fragmentation may be occurring at multiple spatial scales or in across multiple areas, i.e., breeding, staging, and wintering, and therefore, connectivity of suitable habitats is reduced (Haig et al., 1998; Mönkkönen and Reunanen, 1999). Also, access to resources (either habitat itself or food resources) within these sites may be limiting or may become limiting. That is, resources are no longer available in sufficient quantities and/or quality to meet the demands of migration and breeding (Goss-Custard et al., 2006; Newton, 2006; Skagen, 2006). Coastal habitat loss, alteration, and fragmentation are a major concern for those interested in managing these migratory bird populations (Erwin, 1996; USDOI, FWS, 2008a; North American Bird Conservation Initiative, 2009). Development, both commercial and residential, was recognized as a major threat to remaining coastal habitats, ecological diversity, wildlife populations, and species persistence in the southeastern U.S. by Czech and Krausman (1997) and Czech et al. (2000).

Fisheries Interactions

Commercial fisheries may incidentally entangle and drown or otherwise injure birds during fishing operations, or due to lost or discarded fishing gear (see Manville, 2005b; Bull, 2007; Brothers et al., 2010). Avian mortality estimates (i.e., seabird bycatch) associated with commercial fisheries is likely on the order of high thousands to low millions (**Table 4-7**). Until relatively recently, seabird bycatch was considered a major cause for declines in many species of seabirds worldwide (Cooper et al., 2001; Melvin et al., 2001). The longline fisheries in the Gulf of Mexico primarily target pelagic tuna and swordfish, bottom shark, and other reef species. Within the region, the total incidental seabird bycatch for the bottom longline fisheries was one gull of unidentified species, two brown pelicans, one herring gull, and two unidentified seabirds from 2005 to 2008; for the pelagic fishery, it was one brown pelican and two unidentified seabirds from 1992 to 2005 (Hale et al., 2009).

Both NMFS and FWS have taken proactive steps to mitigate these losses through modifications to the equipment used, fishery closures in certain areas, time-of-year and time-of-day closures by some states, and use of fishery observers (Melvin et al., 1999 and 2001; Cooper et al., 2001). With these recent changes in policy, procedures, and techniques, cumulative impacts to future bird bycatch of longline fisheries on marine birds in the northern Gulf of Mexico should be much reduced. There is likely overlap between many species of seabirds, their prey, and some fisheries. Fisheries may impact certain seabird populations by removing preferred prey, or may alter food-web dynamics by removing top-level predators (e.g., blue- and yellow-fin tuna) (Furness, 2003). In addition, substantial quantities of by-catch (i.e., nontarget species + offal + discards) are discarded as waste overboard, and though detrimental to the ecosystem as a whole (Crowder and Murawski, 1998; Harrington et al., 2005), may actually benefit some species of seabirds (Furness, 2003; Votier et al., 2004). Overharvest of some fish populations, particularly top-level predatory fishes, appears to be occurring at unprecedented levels worldwide (Myers and Worm, 2003). Unfortunately, the loss of these top-level predators can have unknown and potentially dramatic effects on marine food-web dynamics and the ocean ecosystem as a whole, including seabird populations reliant on various species of smaller prey fish (Furness and Camphuysen, 1997; Piatt et al., 2007).

Summary and Conclusion

Human-induced disturbance effects often tend to get overlooked or underestimated as a potential population-limiting factor for birds (Hockin et al., 1992; Newton, 1998, pp. 365-369). The cumulative effect on coastal and marine birds from all sources is expected to result in changes in species composition and distribution, and a discernable (i.e., low thousands; **Table 4-7**) decline in the number of birds that form localized groups or populations. Some of these changes are expected to be permanent and to stem from a net decrease in preferred habitat for all birds, and possibly impacts to and declines in critical habitat for some endangered species (**Table 4-14**). However, the incremental contribution of a CPA proposed action to the cumulative impact is considered adverse, but not significant, because the effects of the most probable impacts, such as sale-related operational discharges and helicopters and service-vessel noise and traffic, are expected to be sublethal; and some displacement of local individuals or flocks may occur, and displaced birds may move to other habitats, if available.

In general, the net effect of habitat loss from oil spills, OCS pipeline landfalls, and maintenance and use of navigation waterways, as well as habitat loss and modification resulting from coastal facility construction and development, will probably reduce the overall carrying capacity of the disturbed habitat(s). That is, impacted habitats may result in reductions to both species composition (fewer species) and abundance (lower numbers) as compared with what the area supported historically. These would be the most serious cumulative impacts on birds.

Nocturnal circulation events at platforms are assumed to have mostly sublethal impacts on migrating bird populations. However, oil and gas platforms in the GOM (and associated lighting) results in collision-related mortality of 200,000-321,000 birds/year (**Table 4-7**); these numbers will increase as a result of a CPA proposed action. Similarly, some unknown number of birds that stopover on platforms is preyed upon by migrating raptors (Russell, 2005). Overall, offshore oil and gas platform-related avian mortality, though representing an additional source of mortality, represents a small fraction compared with other sources of anthropogenic mortality (**Table 4-7**; see also Arnold and Zink, 2011). The mortality estimates related to offshore oil and gas activities are well below that for vehicles, buildings and windows, power lines, and communication towers (**Table 4-7**).

The DWH event and associated spilled oil that made it into the nearshore and coastal environment resulted in the loss of ~7,250 birds. In addition, spill-response activities likely exacerbated impacts, particularly for breeding birds nesting on the beaches, barrier islands, and other habitats that were intensively monitored. It is probable that impacts to the avian community in the CPA were far greater than impacts to the avian community in the WPA. The total number of birds killed by the DWH event was likely biased low. In addition, it will be years before a reliable, model-based estimate of mortality that accounts for detection-related issues is provided (e.g., Flint et al., 1999; see also Byrd et al., 2009). Presently, the best available information does not provide a complete understanding of the effects of the spilled oil or the recovery potential for the most impacted species (**Tables 4-8, 4-12, and 4-13**).

Unavailable information on the cumulative effects to coastal and marine birds, including after the DWH event (and thus related changes to the avian baseline in the affected environment), makes an understanding of the potential impacts from a CPA proposed action less clear. The BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to coastal and marine birds. Nevertheless, relevant data on the status of bird populations after the DWH event may take years to acquire and analyze through the NRDA process, and impacts from the DWH event may be difficult or impossible to discern from other factors. There are 4,377 active leases (as of May 2012) in the CPA with ongoing (or the potential for) exploration, drilling, and production activities. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted methods and approaches. However, BOEM believes that this incomplete or unavailable information regarding effects of the DWH event on birds would not likely be essential to a reasoned choice among alternatives. Compared with non-OCS Program factors, such as habitat loss, collisions with non-OCS-related structures, disease and other anthropogenic factors, which may result in billions of bird deaths, the incremental effect of a CPA proposed action is particularly small. Any information obtained from the DWH event is unlikely to be so significant as to change the relative importance of non-OCS factors to bird populations.

Disease is often lethal and may take millions of birds annually, but it should be considered a "naturally" occurring avian mortality factor unless the pathogen is introduced by humans (see Newton, 1998). Storms and floods represent natural, often major disturbances to which exposed organisms are generally adapted. An exception would be hurricane-related storm surges, which are exacerbated by coastal wetland loss in Louisiana and throughout the northern GOM (Costanza et al., 2008; Engle, 2011). Effects from sea-level rise may be particularly severe for many species of breeding marsh birds and shorebirds (e.g., brown pelican, sandwich tern, black skimmer, Forster's tern, laughing gull, gull-billed tern, royal tern, snowy plover, least tern, and Wilson's plover; USDOI, FWS, 2010a), as well as several species of wintering shorebirds that rely on beaches, flats, dunes, sandbars, shorelines, islands, estuaries, and other low-lying, tidally-influenced habitats in the Gulf of Mexico (Galbraith et al., 2002; North American Bird Conservation Initiative, 2010). Even a nominal rise in sea level (USDOC, NOAA, 2011a, pp. 36-37) would inundate much of this habitat, making it unsuitable for many, if not most, of these species.

In conclusion, the incremental contribution of a CPA proposed action to the cumulative impact is considered adverse, but not significant when compared with the impacts of non-OCS Program-related factors.

4.2.1.17. Gulf Sturgeon

The description of the existing condition of the resource and its habitat that follows best describes both the known and currently unknown conditions as affected by both the series of intense hurricanes (Katrina, Rita, Gustav, and Ike) and the DWH event. Post-storm monitoring of some of the coastal sturgeon populations has been completed and the resulting status of those populations is included as part of the existing conditions noted below. While the actual effects of the DWH event are currently unknown, it is estimated that some of the oiled shorelines are within Gulf sturgeon known habitat. The effect of oiling on these habitats is not known at this time due to the ongoing NRDA process. A more accurate assessment of the existing conditions of this resource and its habitat will be forthcoming as monitoring information is gathered and results are made publicly available.

4.2.1.17.1. Description of the Affected Environment

Protected Status

The NMFS and FWS listed the Gulf sturgeon as a threatened species on September 30, 1991. Subsequently, a recovery plan was developed to ensure the preservation and protection of Gulf sturgeon spawning habitat (USDOI, FWS and Gulf States Marine Fisheries Commission, 1995). Critical habitat was proposed on June 6, 2002, in the *Federal Register* (2002) and was designated on April 18, 2003. Critical habitat is defined as specific geographic areas that are essential for the conservation and recovery of a threatened or endangered species and that may require special management consideration or protection. The following geographic areas in the Gulf of Mexico's rivers and tributaries were included in the critical habitat designation:

- Pearl and Bogue Chitto Rivers in Louisiana and Mississippi;
- Pascagoula, Leaf, Bowie (also referred to as Bouie), Big Black Creek, and Chickasawhay Rivers in Mississippi;
- Escambia, Conecuh, and Sepulga Rivers in Alabama and Florida;
- Yellow, Blackwater, and Shoal Rivers in Alabama and Florida;

- Choctawhatchee and Pea Rivers in Florida and Alabama;
- Apalachicola and Brothers Rivers in Florida; and
- Suwannee and Withlacoochee Rivers in Florida.

The critical habitat also includes portions of the following estuarine and marine areas:

- Lake Pontchartrain (east of the Lake Pontchartrain Causeway), Lake St. Catherine, Little Lake, The Rigolets, Lake Borgne, Pascagoula Bay, and Mississippi Sound systems in Louisiana and Mississippi, and sections of the adjacent State waters within the GOM;
- Pensacola Bay system in Florida;
- Santa Rosa Sound in Florida;
- nearshore GOM in Florida;
- Choctawhatchee Bay system in Florida;
- Apalachicola Bay system in Florida; and
- Suwannee Sound and adjacent State waters within the GOM in Florida.

The primary constituent elements of these designated areas that are considered essential for the conservation of the Gulf sturgeon include abundant food items; riverine spawning sites with appropriate substrates; riverine aggregation sites; a flow regime necessary for normal behavior, growth, and survival of all riverine life stages; water quality with the characteristics needed for normal behavior, growth, and viability of all life stages; sediment quality needed for normal behavior, growth, and viability of all life stages; and safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats. The critical habitat for Gulf sturgeon encompasses approximately 2,783 river kilometers (1,730 river miles) and 6,042 km^2 (2,333 mi^2) of estuarine and marine habitat. Major shipping channels have been excluded in the critical habitat units.

Threats to Gulf Sturgeon

The decline of the Gulf sturgeon is believed to be due to overfishing and habitat destruction, primarily the damming of coastal rivers and the degradation of water quality (Barkuloo, 1988). In the late 19th century and early 20th century, the Gulf sturgeon supported an important commercial fishery providing eggs for caviar, flesh for smoked fish, and swim bladders for isinglass (a gelatin used in food products and glues) (Carr, 1983). Dams and sill construction that occurred mostly after 1950 restricted access to historic spawning areas (Wooley and Crateau, 1985), which exacerbated habitat loss, and overfishing resulted in the decline of the Gulf sturgeon throughout most of the 20th century. In several rivers throughout its range, dams have severely restricted sturgeon access to historic migration routes and spawning areas. Dredging and other navigation maintenance that includes lowering river elevations, eliminating deep holes, and altering rock substrates may have adversely affected Gulf sturgeon habitats (Wooley and Crateau, 1985). Contaminants, both agricultural and industrial, may also be a factor in their decline. Organochlorines have been documented to cause reproductive failure in the Gulf sturgeon, reduced survival of young, and physiological alterations in other fish (White et al., 1983). In addition, Gulf sturgeon appear to be natal spawners with little, if any, spawning from other riverine populations.

Today, the greatest habitat threat to sturgeon is the damming of coastal rivers because sturgeon cannot pass through the lock and dam systems to reach spawning areas. In addition to damming, reservoir control and fluctuation of release rates during drought conditions are all factors affecting the spawning rivers downstream of major urban water supply reservoirs. Dredging, clearing/desnagging, and spoil deposition associated with channel maintenance and improvement also present a threat to sturgeon spawning habitat. Poor water quality because of pesticide runoff, heavy metals, and industrial contamination may be affecting sturgeon populations (USDOI, FWS and USDOC, NMFS, 2009; USDOC, NMFS, 2012b). Habitat loss continues to pose major threats to the recovery of the species.

Natural Impacts

Natural phenomena such as tropical storms and hurricanes occur along the Gulf Coast with varying frequency and intensity between years. Although these are usually localized and sporadic, the 2004-2005 storm seasons brought major and repeated damage to the Gulf Coast area. The effects from Hurricane Katrina (2005) are still being assessed. It was noted that Hurricanes Gustav and Ike (2008) did initially displace some of the Gulf sturgeon in the Louisiana/Mississippi area. Current surveys along the Mississippi coast indicate no permanent impact to critical habitat and acknowledge that the sturgeon has returned to their normal feeding and resting areas along the coastal rivers. The 2008 sampling effort in the Pascagoula River system and estuary was insufficient to conclude if there was any change in composition or spawning in that year (Slack, official communication, 2008). More recent information from the Pascagoula Sturgeon Team from the University of Southern Mississippi reported five Gulf sturgeon were caught in 2010 and ranged in size from 570 to 1,500 mm (22 to 59 in) total length, which may be indicative of recovery under post-Katrina conditions (Havrylkoff, official communication, 2010). While a complete assessment of habitat damage due to hurricanes has not been fully executed for Gulf sturgeon based on the recent sampling results, the effects are hypothesized to be temporary (Parauka, official communication, 2007). Slack noted that Hurricanes Gustav and Ike did initially displace some of the Gulf sturgeon in the Louisiana/Mississippi area, much like what happened in Florida during Hurricane Katrina (Slack, official communication, 2011a). Slack reported no permanent impact to critical habitat and acknowledged that the sturgeon have returned to their normal feeding and resting areas along the coastal rivers. Sampling is not yet complete in the effort to conclude if the population has had any change in composition or if spawning has occurred this year.

The areas most impacted from tropical cyclonic events included a large portion of the designated critical habitat and known locations of Gulf sturgeon. The sturgeons are upstream in freshwater riverine habitats during the Atlantic hurricane season. This may give the estuarine and marine areas time to recover from hurricane impacts before the sturgeon move downstream. For instance, massive runoff due to flooding rains and swollen tributaries could cause a sharp increase in toxic contaminants in estuarine habitats. However, spreading and dilution should mitigate any threat to sturgeon quickly. By the time the downstream migration occurs, conditions should have returned to near normal. The flooding and subsequent "unwatering" of New Orleans in the fall of 2005 created concern for any sturgeon that might have been in areas of Lake Pontchartrain where those contaminated flood waters were pumped. The COE noted in their environmental assessment that temporary impacts to Gulf sturgeon may have resulted as a part of the "unwatering" activities related to the pumping of floodwaters into Lake Pontchartrain (U.S. Dept. of the Army, COE, 2005a). Impacts due to the quantity and quality of the floodwaters may have caused some sturgeon to seek forage and resting areas in other more undisturbed locations of the lake. It was expected that any sturgeon displaced returned to the area once the "unwatering" activities ceased (U.S. Dept. of the Army, COE, 2005a). The COE also noted that the emergency procedures permitted in Panama City, Florida, after Hurricane Ivan (2004) may have created temporary impacts to species, including the Gulf sturgeon, but that the emergency procedures did not adversely impact the species (U.S. Dept. of the Army, COE, 2005b). After Hurricane Katrina, there were reports of fish kills and at least one confirmed report of a dead Gulf sturgeon due to low oxygen in the water from organic input from leaf litter and other sources such as raw sewage and untreated effluent (Cummins, 2005). Many municipalities or sources of discharges lost power and/or were flooded and were likely a source of contaminant discharge.

Deepwater Horizon ***Event***

Aside from the recent hurricane activity, the DWH event released an estimated 4.9 MMbbl of oil from the well over an 87-day period. A comparison of oil-spill overlay maps with the Gulf sturgeon critical habitat maps indicates that all but the most eastern regions of the sturgeon habitat had been exposed to oil (USDOC, NOAA, 2010o; OSAT-2, 2011). The "oil exposed" habitat is found from the Chandeleur Islands in Louisiana to the mouth of the Pearl River and adjoining estuaries in both Louisiana and Mississippi, along the Gulf Islands National Seashore through Mobile Bay along the Alabama and Florida coasts to central Florida. While the exposure to spilled oil was not continuous in all locations, all areas were either moderate to lightly oiled, either onshore or on the surface, based on maps prepared by SCAT observers and posted on the National Oceanic and Atmospheric Administration's ERMA website

(USDOC, NOAA, 2010o). It is most probable that the oil reaching these areas from the spill site was either weathered, treated (with dispersant), or both. The toxicity cannot be verified at this time due to ongoing NRDA assessments in these areas. While these sturgeon habitats and foraging areas must be considered as oil-affected, for the purpose of the existing environmental conditions for this resource, no assessment of effects can be made at this time due to lack of publicly available data. Based on the publicly available information found in OSAT (2010), it was noted that, after August 2010, the more toxic oil components were limited to an area within 3 km (~2 mi) of the wellhead. Outside of this area, both water column and sediment samples did not reach USEPA's exceedances for aquatic life benchmarks (including PAH's) (OSAT, 2010). The most current shoreline oiling data (USDOC, NOAA, 2011f) is not delineated by shoreline miles and qualitatively (mapping graphics) indicates light to no remnant oil in Gulf sturgeon critical habitat. The very light remnant oil observed is only in a small area west of the Rigolets Pass in Louisiana. From the Rigolets Pass in Louisiana to Panama City, Florida, there is no remnant oil indicated in Gulf sturgeon critical habitat or nearshore waters. As NRDA data are analyzed and released, along with independent study data, a more refined assessment of the existing conditions of this resource and its habitat will be forthcoming.

ESA Consultation

On July 30, 2010, BOEMRE reinitiated ESA Section 7 Consultation on the previous 2007-2012 Multisale EIS for the Western and Central Planning Areas of the Gulf of Mexico with both FWS and NMFS. This request was made as a response to the DWH event and is meant to comply with 50 CFR 402.16, "Reinitiation of formal consultation." At present, BOEM is acting as the lead agency in the ongoing consultation, with BSEE assistance and involvement. The BOEM, BSEE, NMFS, and FWS are in the process of collecting information in order to update the environmental baseline information as needed for this reinitiated Section 7 consultation. As BOEM moves forward with the new Five-Year Program (2012-2017), BOEM and BSEE have implemented an interim coordination and review process with NMFS for ongoing activities.

The purpose of this coordination is to ensure that NMFS has the opportunity to review postlease exploration, development, and production activities prior to BSEE approval and to ensure that all approved plans and permits contain any necessary measures to avoid jeopardizing the existence of any ESA-listed species or precluding the implementation of any reasonable and prudent alternative measures. With consultation ongoing, BOEM and BSEE will continue to comply with all Reasonable and Prudent Alternative Measures and the Terms and Conditions under these existing consultations, along with implementing the current BOEM- and BSEE-required mitigation, monitoring, and reporting requirements. Based on the most recent and best available information at the time, BOEM and BSEE will also continue to closely evaluate and assess risks to listed species and designated critical habitat in upcoming environmental compliance documentation under NEPA and other statutes (**Chapter 5.7**).

Additional Background Information on Species

Stocks and Distribution

The critical rivers and their associated estuaries include the Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and the Suwannee Rivers. Reproducing populations continue to be evident in these seven river systems. Sturgeon reproduction is not known to currently occur in the Mobile Basin where it most likely occurred historically; however, slow recolonization may be occurring as evidenced by the recent catch of Gulf sturgeon near Fairhope, Alabama (Mettee et al., 2009). The estimated Gulf sturgeon population on the Suwannee River has increased from less than 500 in the 1980's to 2,000 fish in 2005 (Pine and Martell, 2009). The number of Gulf sturgeon in the Escambia River may have recently declined due to intense hurricane activity.

Telemetry data documented Gulf sturgeon from the Pearl River and Pascagoula River subpopulations migrating from their natal bay systems to Mississippi Sound and moving along the barrier islands near the barrier island passes between Horn and Ship Islands, as well as between Horn and Petit Bois Islands (Ross et al., 2001). Gulf sturgeon from the Choctawhatchee, Yellow, and Apalachicola Rivers have been documented migrating in the nearshore GOM waters between Pensacola and Apalachicola Bay units (Fox et al., 2000).

The historic range of the Gulf sturgeon included nine major rivers and several smaller rivers from the Mississippi River, Louisiana, to the Suwannee River, Florida, and the marine waters of the central and eastern GOM to Tampa Bay (Wooley and Crateau, 1985; USDOI, FWS and Gulf States Marine Fisheries Commission, 1995). Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay (Wooley and Crateau, 1985; Reynolds, 1993).

While little is known about the abundance of Gulf sturgeon throughout most of its range, population estimates have been calculated for the Apalachicola, Choctawhatchee, and Suwannee Rivers. The FWS calculated an average (from 1984 to 1993) of 115 individuals (greater than 45 cm [18 in] total length) over-summering in the Apalachicola River below Jim Woodruff Lock and Dam (USDOI, FWS and Gulf States Marine Fisheries Commission, 1995). Preliminary estimates of the size of the Gulf sturgeon subpopulation in the Choctawhatchee River system are 2,000-3,000 fish over 61 cm (24 in) total length. The Gulf sturgeon subpopulation in the Suwannee River are 7,650 individuals over 60 cm (24 in) total length and older than age 2 (Sulak and Clugston, 1999). Although the size of the Suwannee River sturgeon population is considered stable, the population structure is highly dynamic as indicated by length frequency histograms (Sulak and Clugston, 1999). Strong and weak year-classes, coupled with the regular removal of larger fish, limit the growth of the Suwannee River population but stabilize the average population size (Sulak and Clugston, 1999).

Five genetically based stocks have been identified by NMFS and FWS: (1) Lake Pontchartrain and Pearl River; (2) Pascagoula River; (3) Escambia and Yellow Rivers; (4) Choctawhatchee River; and (5) Apalachicola, Ochlockonee, and Suwannee Rivers. Mitochondrial DNA analyses of individuals from subpopulations indicate that adults return to natal river areas for feeding and spawning (Stabile et al., 1996). While some displacement of Gulf sturgeon was noted after Hurricane Katrina, mortality was minimal for populations from the Pearl River drainage and Louisiana along the western range of the critical habitat (Kirk, 2008). It was also noted that, despite the location of juvenile populations of sturgeon in the lower Pearl River, there was no summertime use of either the Mississippi River Gulf Outlet or the adjacent disposal sites (Kirk, 2008).

Fisheries scientists interrupt migrating Gulf sturgeon in the rivers and estuaries by capture with nets suspended from floats in the rivers and river mouths to determine if these fish are showing signs of natal river fidelity. Gill nets with mesh wide enough not to close the very large opercula are used. No capture or tracking is feasible in the open Gulf when the fish migrate because cold fronts come every 2-3 days, with seas up to 3 m (9 ft). These conditions are dangerous for the size of vessel required, and the paths traveled in the open Gulf cannot be followed beyond the estuaries. Thus, the offshore winter distribution of Gulf sturgeon relative to the location of the activities under a CPA proposed action is unknown.

Habitats

Gulf sturgeon occur in most major tributaries of the northeastern GOM from the Mississippi River east to Florida’s Suwannee River, and in the central and eastern Gulf waters as far south as Charlotte Harbor, Florida (Wooley and Crateau, 1985). In Florida, Gulf sturgeons are still found in the Escambia, Yellow, Blackwater, Choctawhatchee, Apalachicola, Ochlockonee, and Suwannee Rivers (Reynolds, 1993).

Critical habitat extends from east of the Lake Pontchartrain Causeway Bridge in Louisiana to the Suwannee Sound in Florida. Although this is not the full range of occurrence of Gulf sturgeon, these areas constitute the most crucial habitat designated for the conservation of the Gulf sturgeon. The adult fish tend to congregate in deeper waters of rivers with moderate currents and sand and rocky bottoms. Seagrass beds with mud and sand substrates appear to be important marine habitats (Mason and Clugston, 1993). Telemetry data from the GOM mainly show sturgeon in depths of 6 m (19.8 ft) or less (Fox et al., 2000; Ross et al., 2001). In the Choctawhatchee Bay system, sturgeon were found in nearshore water depths of 2-4 m (7-13 ft). Areas of the bay where the Gulf sturgeon remained for long periods were characterized by sandy substrates with benthic communities dominated by crustaceans and annelids.

Habitats used by Gulf sturgeon in the vicinity of the Mississippi Sound barrier islands tend to have a sand substrate and an average depth of 1.9-5.9 m (6.2-19.4 ft). Where estuary and bay unvegetated “mud” habitats have a preponderance of natural silts and clays supporting Gulf sturgeon prey, the Gulf sturgeon found there are assumed to be using these habitats only for foraging.

Life Cycle

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*), a subspecies of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrhynchus*), has a subcylindrical body embedded with bony plates (scutes), a greatly extended snout, ventral mouth with four anterior chin barbels, and a heterocercal tail (Vladykov, 1955). Adults range from 1.8 to 2.4 m (5.9 to 7.9 ft) in length, with females attaining a greater length and mass than males.

Sturgeons are bottom suction feeders that have ventrally located, highly extrudable mouths. The sturgeon head is dorsoventrally compressed with eyes dorsal so benthic food under the sturgeon's mouth is not visible. They have taste barbels, like catfish, to detect benthic prey. The barbels are also useful for feeding in high-order streams if visibility is low or at night.

The species is anadromous—feeding in the winter months in the marine waters of the Gulf of Mexico including bays and estuaries, migrating in the spring up freshwater rivers to spawn on hard substrates, and then spending summers in the lower rivers before emigrating back out into estuarine/marine waters in the fall.

Gill netting and biotelemetry have shown that subadults and adults spend 8-9 months each year in rivers and 3-4 of the coolest months in estuaries or Gulf waters. Individuals are long-lived, some reaching at least 42 years in age (Huff, 1975). In spring, large subadults and adults that migrate from the estuaries or the Gulf into major river passes feed primarily on lancelets, brachiopods, amphipods, polychaetes, and globular molluscs. Small sturgeons that remain in river passes during spring feed on amphipods, shrimp, isopods, oligochaetes, and aquatic insect larvae (Clugston, 1991). During the riverine stage, adults cease feeding, undergo gonadal maturation, and migrate upstream to spawn. Spawning occurs in freshwater reaches of the river, over coarse substrate in deep areas or holes with hard bottoms and where some current is present (Sulak and Clugston, 1998; Fox et al., 2000). Until recently, only two spawning sites were known, both in the Suwannee River in Florida. Eggs have now been discovered in six locations within the Choctawhatchee River system in Alabama and Florida (Fox and Hightower, 1998). The age of sexual maturity for females ranges from 8 to 17 years and the age of sexual maturity for males ranges from 7 to 21 years (Huff, 1975). High fecundity (egg number) facilitates wide dispersal, a major adaptation to the high variance of conditions resulting from diverse habitats and the dynamic nature of main stems of watersheds that would otherwise reduce survival rates of juveniles. A large female was reported to have the capability of producing 275,000-475,000 eggs (Chapman et al., 1993). These eggs are adhesive and attach to rocks, vegetation, or other objects. They hatch in about 1 week depending upon the temperature of the water. Gulf sturgeon eggs are demersal (sink to the bottom) and adhesive (Fox et al., 2000). Although fry and juveniles feed in the riverine environment, subadults and adults do not (Mason and Clugston, 1993; Sulak and Clugston, 1999). Subadult and adult Gulf sturgeon then spend cool months (October/November through March/April) in estuarine areas, bays, or in the GOM (Odenkirk, 1989; Clugston et al., 1995).

Species Movement

Recent studies found Gulf sturgeon movements may be influenced by the search for and availability of food, preferable hydrological conditions, and spawning substrates. Sulak and Clugston (1999) describe a hypothesis that Gulf sturgeon spread along the coast in nearshore waters in depths less than 10 m (33 ft), and available data support this hypothesis. Evaluation of tagging data has identified several nearshore GOM feeding migrations but no offshore GOM feeding migrations. Brooks and Sulak (2005) noted while identifying food sources in the Suwannee Estuary that the benthic infauna biomass was greater in the summer than the winter and that the distribution of benthic food sources was patchy. During an assessment of the benthic food source in the Choctawhatchee Bay (Heard et al., 2002), a change in species composition was noted possibly as a result of nutrient overloading during Hurricane Ivan. This may explain the back and forth movement of sturgeon from this area to other areas where more benthic forage is available. Edwards et al. (2003 and 2007) noted patterns on tagged fish in the Suwannee Estuary that indicated the sturgeon in this area were searching for food where the supply was patchy; thus, erratic movements were observed. They also noted some consistent and directed movement patterns, indicating that these fish may remember where the most abundant food sources are located and return to these locations each year. These back and forth patterns of movement up and down the estuary, as well as between rivers, may explain both the lack of river fidelity and the sharing of marine and estuarine forage areas when food sources are not abundant.

Fox and Hightower (2002) tracked and confirmed adult sturgeon that have migrated >100 km (62 mi) into the marine environment. While it has been hypothesized that some adults may remain in the open Gulf for as much as 2 years, the location of the Gulf foraging grounds is still unknown (Fox et al., 2002). Most of the male sturgeon remained in the Choctawhatchee Bay during the winter and spring, while most females were either in the Gulf of Mexico or last detected at the Bay entrance (Fox et al., 2002).

The Gulf sturgeon move from bays to the deeper waters around barrier islands and eventually relocate to the shallow bay waters again. In both deep and shallow waters sturgeon demonstrate localized movements within an area for extended lengths of time (>2 weeks), but they will rapidly move to a different area where localized patterns of movement are once again observed (Fox et al., 2002).

As noted above, BOEM acknowledges that there remains incomplete or unavailable information on Gulf sturgeon, including potential impacts from the DWH event (and thus changes to the Gulf sturgeon baseline in the affected environment). This makes an understanding of the affected environment and impacts from a CPA proposed action less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to Gulf sturgeon. Nevertheless, BOEM believes that this incomplete or unavailable information regarding the effects of the DWH event on Gulf sturgeon may be essential to a reasoned choice among alternatives. Relevant data on the status of Gulf sturgeon populations after the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis (including data on related fish species such as the Caspian Sea sturgeon) and applied this information based upon accepted scientific methods and approaches.

4.2.1.17.2. Impacts of Routine Events

Background/Introduction

Potential impacts to the threatened Gulf sturgeon and their designated critical habitat from routine activities associated with a CPA proposed action may occur from drilling and produced-water discharges, degradation of estuarine and marine water quality from infrastructure, dredging activities, vessel traffic, pipeline installation, and explosive platform removal. Designated Gulf sturgeon critical habitat occurs in estuarine and riverine locations along the Gulf Coast east of the Mississippi River in Louisiana to Florida. Designated Gulf sturgeon critical habitat is confined to State waters, and navigation channels are exempt from the critical habitat status. Most activities related to a CPA proposed action would occur in Federal waters (i.e., structure placement, drilling, removal, etc.). Though critical habitat may be impacted directly or indirectly, such impacts are expected to be negligible due to the distance of Gulf sturgeon habitat and life cycles from most activities related to a CPA proposed action.

Proposed Action Analysis

Drilling mud and produced-water discharges contain chemical components that may be detrimental or toxic to Gulf sturgeon. Toxicity from drilling muds would require concentrations four or five orders of magnitude higher than concentrations found a few meters from the discharge point. Produced-water discharges may result in moderate heavy-metal and hydrocarbon contamination of sediments and extend through the water column out to several hundred meters down current from the discharge point (CSA, 1997b).

The components of produced water consist of metals, trace elements, monocyclic aromatic hydrocarbons, PAH's, and various organic chemicals. Berg (2006), in his literature review of contaminants that affect Gulf sturgeon, found that, while pH and water hardness may have an effect on the availability and uptake of heavy and trace metals, some sturgeon species were seen to adsorb these compounds into their ovarian tissue and sperm at levels that reduced reproductive success. In general, many metals have similar impacts on fishes. The majority of metals accumulate externally in the mucous of the gill tissues, although metals also disrupt numerous physiological functions in fish (Berg, 2006). Other studies identified the potential effects of contaminants on sturgeon, and these include muscle atrophy, abnormality of gonad, sperm and egg developmental issues, morphogenesis of organs, tumors, and disruption of hormone production (Graham, 1981; Altuf'yev et al., 1992; Dovel et al., 1992; Georgi, 1993; Romanov and Sheveleva, 1993; Khodorevskaya et al., 1997; Kruse and Scarnecchia, 2002). Since the Gulf sturgeon spends most of its time either in nearshore coastal environments or in inland rivers, the potential for encountering produced-water impacts or direct discharges from a production platform is small. Produced water creates a localized area of effect close to the discharge and is mostly limited to benthic sediments in the immediate vicinity of the discharge. In OCS activities, produced waters provide the main source of metals (i.e., arsenic, barium, cadmium, chromium, copper, lead, and zinc) to benthic sediments.

All of these metals are natural constituents of clean seawater. Barium, chromium, copper, iron, nickel, and zinc are frequently found in produced water in higher concentrations than those naturally found in seawater. The complex geochemistry of these metals affects their ability to produce adverse effects in the marine environment. Most of these metals are used as trace nutrients by marine organisms and, therefore, metal concentrations in the tissue make it difficult to determine bioaccumulation in these organisms. As a rule, concentrations of metals in tissues of marine organisms in the GOM and in the immediate vicinity of offshore discharges of produced water are in the normal range and do not show any evidence of bioaccumulation to potentially toxic levels for the organisms themselves or their consumers, including man (Neff, 2002b). Neff (2002b) noted that copper and cadmium were typically the metals identified in GOM produced water. Any adverse effects of these metals, if they occur at all, are likely to be highly localized.

Monocyclic aromatic hydrocarbons are found in produced water; however, because of their high volatility, they are lost rapidly in the seawater following discharge. Most of these volatile compounds are immediately diluted to background levels within 100 m (328 ft) of the discharge. The compounds have a low potential to be bioaccumulated by marine organisms and do not adsorb to sediments. Therefore, they pose a very low risk of harm to marine organisms and human consumers of seafood.

Some PAH's bioaccumulate and are often found in sediments near produced-water discharges. Although some of the PAH's do have a tendency to bioaccumulate, those particular constituents are in such low concentrations in the produced water that they are considered to be low risk to marine ecosystems in the vicinity of the produced-water discharges. The major source of the more damaging PAH compounds are found as a component of soot from various combustion sources, and they do not biomagnify in the marine food web so they do not pose a hazard to fish that consume biofouling organisms from submerged platform structures (Neff et al., 1987). The PAH's have a low to moderate risk to marine organisms or human consumers of fishery products.

While not specifically addressing Gulf sturgeon, it has been observed with surrogate species (i.e., brook trout, Caspian Sea sturgeon, and white sturgeon) that, if exposed to sublethal concentrations of contaminants containing metals and hydrocarbon components, then this may result in impaired physiological function and behavior in these fish species. The range of issues may include endocrine disruption that impacts reproduction and osmoregulation, immune system suppression, inhibition of the olfactory system, inhibition of the nervous system that interferes with behavior, and biochemical changes and developmental interference. All of these on their own may increase mortality and impair the recovery of a population or species (Berg, 2006).

However, offshore discharges of drilling muds and produced waters are expected to dilute to background levels within 1,000 m (3,281 ft) (CSA 1997). Most Gulf sturgeon would not be expected to be encountered on the OCS in the area of produced discharges, although offshore movement has not been definitively studied. Sturgeon are not known to be attracted to petroleum structures or activity, which is where the discharges would be the most concentrated. The produced waters associated with OCS activities have various chemical constituents that have varying potential of concern to the Gulf sturgeon. Produced water and drilling muds are regulated by NPDES permits, which mandate maximum contaminant levels within the discharges. Due to these restrictions and the rapid dilution within offshore waters, significant impacts are not expected.

Minor degradation of estuarine water quality is expected in the immediate vicinity of shore bases and other OCS Program-related facilities as a result of routine effluent discharges and runoff. Rapid dilution is expected to negate any impact to critical habitat or Gulf sturgeon from these sources.

A CPA proposed action would not require dredging near natal rivers used as migratory routes to upstream spawning areas. While there could be a need for maintenance dredging in the nearshore waters, juvenile or adult sturgeon using these areas have the ability to avoid the dredging activity. The construction and maintenance of navigation channels is regulated by COE, and dredging permits are "conditioned" to avoid and minimize impacts to Gulf sturgeon and their critical habitat. The permitted activity is "conditioned" with specific time windows to exclude dredging during times of sturgeon migration, spawning, or active use of critical nursery areas. These conditioned permits are coordinated with either FWS or NMFS or both, depending on the origin of the dredging operation. At present, BOEM's coordination with NMFS indicates no changes in critical habitat have occurred, and they are working to develop an estimate of sturgeon habitat loss and a Habitat Suitability Index for the species.

Service-vessel traffic running in and out of shore bases may create the potential for impact to Gulf sturgeon. Gulf sturgeon are found at mid-depth in the water column as opposed to bottom depths where they have previously been found in northwest Florida (Robydek and Nunley, 2010). This finding, coupled with the movement between rivers and bays, provides more opportunity for vessel strikes. Because Gulf sturgeons are bottom feeders and are not known to be attracted to areas of activity or disturbance, the probability of a take due to vessel strike is extremely low in the areas located west of the critical habitat.

There is potential for oiled sediments to be resuspended by vessel traffic in the areas where heavy oil was observed near support channels. Major shipping channels, as identified on standard navigation charts and marked by buoys, are excluded from critical habitat designation. However, only a small amount of the routine dredging done in coastal areas would be directly or indirectly due to a CPA proposed action. On average, 9 percent of traffic using navigation channels is related to the OCS Program (**Tables 3-3 and 3-14**). Based on the numbers of service-vessel trips projected for a CPA proposed action and the OCS Program (**Table 3-4 and 3-6**), a CPA proposed action is expected to contribute 3-4 percent of the total OCS Program usage of navigation channels. Therefore, a CPA proposed action would contribute 0.2-0.4 percent to the total commercial traffic using these navigation channels.

Pipeline installation may have the greatest potential for impact to Gulf sturgeon and their critical habitat from a CPA proposed action. Typical methods to lay pipeline can result in bottom and sediment disturbance, burial of submerged vegetation, reduced water clarity, reduced light penetration, and the resulting reduction of seagrass cover and productivity. With these methods, it is assumed that about 5 m^2 (55 ft^2) of sediments per kilometer of pipeline would be resuspended during the installation of 50-850 km (31-528 mi) of pipelines in water depths less than 60 m (200 ft). Such activity would impact the nearshore critical habitat of Gulf sturgeon.

Trenchless, or directional, drilling is a recent technique for pipeline installation that is used in sensitive habitats. Impacts from this technique are limited to the access and staging sites for the equipment, and Gulf sturgeon are expected to avoid lay-barge equipment as well as resuspended sediments. This method has been used successfully to place pipelines under scenic rivers so as not to disturb the bottom water or impact the banks of the river. Since 2002, only one new pipeline (Endymion oil pipeline) has come to shore in Louisiana from OCS-related activities. Based on a review of the data in the COE permit application, the emplacement of the pipeline caused zero impacts to marshes and beaches because of the use of horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Pipeline permit requirements of COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation. These requirements, along with directional drilling capability, would result in impacts to Gulf sturgeon critical habitat that are short term and negligible, if they occur at all.

All of the gas production and most of the oil production from a CPA proposed action is expected to be mingled in offshore pipelines with other OCS production at sea before going ashore, and most would use pipelines already in place. Zero to one pipeline landfall is projected as a result of a CPA proposed action. Should one be constructed, it would most likely be in Louisiana, where the large majority of the infrastructure exists for receiving oil and gas from the CPA. This area is on the extreme western end of the designated critical habitat for Gulf sturgeon.

Platform removal using explosives has the potential to injure or kill a Gulf sturgeon in the near vicinity of a blast. However, current data indicate that Gulf sturgeons generally remain in the estuarine regions near river mouths or in shallow Gulf waters away from OCS platforms in Federal waters. Most OCS platform removal activity occurs from late spring to fall, which coincides with the inland migration of the Gulf sturgeon to their natal rivers where they overwinter, thus excluding them from the deeper estuarine waters where OCS platforms are being removed. Critical habitat is in State waters, well inshore of the location of any oil or gas structure installed as a result of a CPA proposed action. In the very unlikely event that a Gulf sturgeon was far enough offshore to be in the area of an impending structure removal, the associated disturbance and activity is expected to deter the fish from approaching the removal site.

Summary and Conclusion

Potential routine impacts on Gulf sturgeon and their designated critical habitat may occur from drilling and produced-water discharges, bottom degradation of estuarine and marine water quality by nonpoint runoff from estuarine OCS-related facilities, vessel traffic, pipeline installation, and explosive removal of structures. Because of the permitted discharge limits mandated and enforced in the Federal and State regulatory process, the dilution and low toxicity of this pollution is expected to result in negligible impact of a CPA proposed action on Gulf sturgeon. Vessel traffic would generally only pose a risk to Gulf sturgeon when the vessels are leaving and returning to port. Major navigation channels are excluded from critical habitat. Also, the Gulf sturgeon's characteristics of bottom-feeding and general avoidance of disturbance make the probability of vessel strike extremely remote. If any pipeline is installed nearshore as a result of a CPA proposed action, regulatory permit requirements governing pipeline placement and dredging, as well as recent noninvasive techniques for locating pipelines, would result in very minimal impact to the Gulf sturgeon's critical habitat. Explosive removal of structures as a result of a CPA proposed action would occur well offshore of the Gulf sturgeon's critical habitat and the riverine, estuarine, and shallow Gulf habitats where sturgeon are generally located. There is no data indicating that sturgeons are using the deeper Gulf waters where most of the OCS activities occur. In general, the mud substrates found in the Gulf waters do not support the appropriate benthic food source for Gulf sturgeon. Due to regulations, mitigations, and the distance of routine activities from known Gulf sturgeon habitats, impacts from routine activities of a CPA proposed action would be expected to have negligible effects on Gulf sturgeon and their designated critical habitat.

4.2.1.17.3. Impacts of Accidental Events

Potential accidental impacts on Gulf sturgeon and the designated critical habitat may occur primarily from oil spills. The dilution and low toxicity of this pollution is expected to result in negligible impacts on Gulf sturgeon as a result of a CPA proposed action due to the distance these spills would be expected to remain from Gulf sturgeon's critical habitat. However, recent studies have found that Gulf sturgeon spend more time than previously thought at mid-depth as opposed to being strictly utilizing the bottom, especially during movement from one area to another (Robydek and Nunley, 2008). Potential impacts to fish resources from a low-probability catastrophic event are also discussed in **Appendix B**.

Proposed Action Analysis

Potential accidental impacts on Gulf sturgeon and the designated critical habitat may occur from oil spills. The dilution and likely low toxicity of this pollution is expected to result in negligible impacts on Gulf sturgeon as a result of a CPA proposed action, due to the distance these spills would be expected to remain from Gulf sturgeon's critical habitat. However, recent studies have found that Gulf sturgeon spend more time than previously thought at mid-depth as opposed to being strictly utilizing the bottom, especially during movement from one area to another (Robydek and Nunley, 2008).

Oil spills are the OCS-related factor associated with a CPA proposed action most likely to impact the Gulf sturgeon. The brief background information provided in **Chapter 4.2.1.17.1** is to provide insight into the factors in the sturgeons' life history and behavioral patterns that increase its susceptibility to accidental impacts associated with OCS activities. The coastal movements of Gulf sturgeon between estuaries, feeding in barrier island passes and utilizing both shallow and mid-water depths, increases the probability of encountering accidental spills. Other factors that may affect the sturgeon's probability of accidental impact is its long lifespan, its extended residence in riverine and estuarine habitats, and its benthic feeding habitats. These factors enhance the chances of the species long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants including components of spilled oil.

Studies specifically involving Gulf sturgeon and PAH's were not found in the current literature, although a past study found that Gulf sturgeon tissue samples contain concentrations of PAH's (Bateman and Brim, 1994). The PAH toxicity to similar fish (shortnose sturgeon, salmonids) varies substantially, although conclusions of the impacts of PAH's on fish are often generalized due to the difficulty in testing any specific chemical (Berg, 2006). In areas of PAH contamination, fish may produce the means to allow for faster removal rates of PAH's from their system; however, this often transforms the PAH into a more harmful metabolite (O'Conner and Huggett, 1988). Fish exposed to PAH-contaminated sediments have experienced a range of affects including mortality, liver lesions, reproductive problems, fin erosion, skin carcinomas, and gill issues (Malins et al., 1985; O'Conner and Huggett, 1988; Fabacher et al., 1991; Varanasi et al., 1992; Baumann et al., 1996). The reproductive problems noted above relates to the effect of oil and its components on the less mobile eggs, larvae, and juvenile sturgeon that do not have fully developed physiological systems to deal with the oil components especially PAH. In general specific reproductive abnormalities that have been seen in Gulf sturgeon as a result of pollution from oil components are abnormal gonad formation, sperm and egg developmental issues, and disruption of hormone production (Gulf Sturgeon, 5 year review, 2009). In Berg's (2006) "Review of Contaminant Impacts on the Gulf of Mexico Sturgeon" he noted some sturgeon studies from the Caspian Sea that indicate unlike salmonids, sturgeon actively avoided areas contaminated with oil.

There is also speculation that exposure to PAH's may suppress the immune system. Research has documented the occurrence of endocrine disruption in sturgeons from various chemical contaminants, and PAH contamination has resulted in endocrine and reproductive disruption in some salmonids (Matthiesson and Sumpter, 1998). Oil can affect Gulf sturgeon by direct ingestion, ingestion of oiled prey, or the absorption of dissolved petroleum products through the gills. Upon any exposure to spilled oil, liver enzymes of adult fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon could result in mortality or sublethal physiological impacts including irritation of gill epithelium and disturbance of liver function. Behavior studies of other fish species suggest that adult sturgeon are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982). Fish eggs and larvae, with their limited physiology and mobility, are killed when contacted by oil (Longwell, 1977).

Accidental impacts associated with a CPA proposed action that could adversely affect Gulf sturgeon may also include oil spills associated with the transport and storage of oil. The degree of impact from oil spills depends on the location of the spill, oil slick characteristics, water depth, currents, time of year, and weather. Offshore oil spills that occur in a proposed action area are much less likely to contact the Gulf sturgeon or its critical habitat than are inshore spills because of the proximity of the spill to these habitats (**Figures 3-22 and 3-23**). Designated Gulf sturgeon critical habitat occurs in estuarine and riverine locations in State waters along the Gulf Coast east of the Mississippi River in Louisiana, Mississippi, Alabama, and Florida in the CPA. Most activities related to a CPA proposed action would occur in Federal waters; however, critical habitat may be impacted directly or indirectly. Gulf sturgeon are primarily benthic feeders and inhabit mostly nearshore, coastal water environments of moderate depth, except during the riverine spawning period. Because of the floating nature of oil and the small tidal range in the coastal Gulf, oil spills alone would typically have very little impact on benthic feeders such as the Gulf sturgeon. Telemetry data are being collected and analyzed through the NRDA process and are in more seaward locations than previously collected. There are no publicly available or published data concerning these more seaward locations at this time due to the NRDA process. The probability of spilled oil encroachment into an inland waterway is less than that for the adjoining coastal area and diminishes even further as one moves upstream. Spilled oil is unlikely to impact eggs, juvenile, and adult Gulf sturgeon when they are inland during the riverine portion of their life cycle. The juvenile and subadult Gulf sturgeon, at a minimum, seasonally use the nearshore coastal waters and could potentially be at risk from both coastal and offshore spills.

The probability for the occurrence of a spill in the WPA of the size and duration required to impact the Gulf sturgeon critical habitat as well as areas of known Gulf sturgeon occurrence is <0.5 percent (**Figures 3-22 and 3-23**), unless the spill is catastrophic in nature, such as the DWH event (**Appendix B**). The probability for the occurrence of a spill from a CPA proposed action of the size and duration required to impact the Gulf sturgeon critical habitat is low. The probabilities range from 1 to 2 percent for a 10-day exposure to a 2-4 percent for a 30-day probability of exposure (**Figure 3-22**). For areas of known Gulf sturgeon occurrence, it is 2-4 percent for a 10-day exposure and 4-7 percent for a 30-day probability of exposure (**Figure 3-23**). These numbers would change if the spill is catastrophic in nature, such as the DWH event (**Appendix B**).

Except for direct pipeline spills in the nearshore environment, the Gulf sturgeon would be at greater risk of a PAH encounter during the inland river migrations due to the industrial and farm waste introduced into these coastal rivers from the adjacent agricultural and urban land use, as compared with an accidental event resulting from a CPA proposed action. The coastal waters inhabited by Gulf sturgeon and comprising their critical habitat are not expected to be at risk from coastal spills resulting from a CPA proposed action. However, based on the maximum oil observed from OSAT-2 (2011), critical habitat from Lake Borgne to the Florida/Alabama State line has at least been exposed to oil from the DWH event. Based on OSAT reports (OSAT, 2010; OSAT -2, 2011) the treated oil associated with the DWH event that reached coastal waters and beaches did not exceed USEPA benchmarks for aquatic life in either sediments or water. In addition the dispersant emulsified the oil which encouraged evaporation, dilution and biodegradation of toxic components including PAH's. Contamination was limited to within 3 km (~2 mi) of the wellhead well away from the Gulf sturgeon critical habitat. The dispersed oil was rendered into a cloud-like mass within the water column which was readily available for biodegradation.

There is a possibility that forage patterns and migration patterns of sturgeon may change along the coast if former foraging areas have been affected by the oil from the DWH event. Telemetry data concerning sturgeon movement are being collected and analyzed from nearshore and offshore buoy systems through the NRDA process. The likelihood of another catastrophic spill event of sufficient size and duration to impact coastal environments, however, remains exceedingly low.

As noted above, BOEM acknowledges that there remains incomplete or unavailable information on Gulf sturgeon, including potential impacts from the DWH event (and thus changes to the Gulf sturgeon baseline in the affected environment). This makes an understanding of the affected environment and impacts from an accidental event associated with a CPA proposed action less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to Gulf sturgeon. Nevertheless, BOEM believes that this incomplete or unavailable information regarding effects of the DWH event or future accidental events on Gulf sturgeon may be essential to a reasoned choice among alternatives. Relevant data on the status of Gulf sturgeon populations after the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis (including data on related fish species such as the Caspian Sea sturgeon) and applied this information based upon accepted scientific methods and approaches.

Summary and Conclusion

Unusually low tidal events, increased wave energy, or the use of oil dispersants increases the risk of impact with bottom-feeding and/bottom-dwelling fauna. For this reason, dispersants are not expected to be used with coastal spills. Winds and currents would also diminish the volume of a slick. For the Louisiana waters and beaches with a higher probability of oil-spill occurrence than the surrounding areas, the Mississippi River outflow would also serve to help break up a slick that might otherwise contact the area. Spreading of the slick would reduce the oil concentrations that might impact the coastal Gulf sturgeon critical habitat.

The potential risk to sturgeon would result from either direct contact with oil spills (or the potential PAH's introduced through the spill) or, in some cases, long-term exposure to produced water. The likelihood of Gulf sturgeon impacts in coastal waters as a result of OCS activity is reduced by both the distance from a potential spill or production area and the concentration of contaminants that actually reach the area of sturgeon activity. Except for direct pipeline spills in the nearshore environment, the Gulf sturgeon would be at greater risk of a PAH encounter during the inland river migrations due to the industrial and farm waste introduced into these coastal rivers from the adjacent agricultural and urban land uses compared with an accidental event resulting from a CPA proposed action.

The Gulf sturgeon could be impacted by any oil spills that may result from a CPA proposed action. If there is contact with spilled oil, it could have detrimental physiological effects. In the rare event contact with oil occurs, this could cause nonlethal effects, including causing the fish to temporarily migrate from the affected area, irritation of gill epithelium, an increase of liver function in a few adults, and possibly interference with reproductive activity. The juvenile and subadult Gulf sturgeon, at a minimum, seasonally use the nearshore coastal waters and could potentially be at risk from both coastal and offshore spills. Due to the distance of the activity from shore and Gulf sturgeon critical habitat, there is a minimal risk of any oil coming in contact with Gulf sturgeon from an offshore spill. Even for a catastrophic spill, the proximity, type of oil, weather conditions, as well as the amount and location (distance offshore and water depth) of the dispersant treatment, may contribute to the severity of the spill's impact to the sturgeon and its habitat.

4.2.1.17.4. Cumulative Impacts

Proposed Action Analysis

This cumulative analysis summary considers the impacts of all past, present, and reasonably foreseeable future activities plus the contribution of a CPA proposed action that may adversely affect Gulf sturgeon within its range and critical habitat in the northern Gulf of Mexico. Specific types of impact-producing factors considered in this cumulative analysis include oil spills, dredge/channelization activities, natural catastrophes, fishing, and other factors that can result in changes to habitats.

Oil Spills

The Gulf sturgeon could be impacted by oil spills resulting from a CPA proposed action. The highest probability for cumulative impacts to the Gulf sturgeon or its habitat would be from coastal spills or vessel collisions in close proximity to its nearshore feeding and nursery areas. Due to the current distances of a CPA proposed action to the Gulf sturgeon's critical habitat, migratory routes, or nursery and feeding areas, there is a very low probability of impact from spills from this area unless it is catastrophic in nature, such as the DWH event (**Appendix B**).

Direct contact with spilled oil could have detrimental physiological effects. The juvenile and subadult Gulf sturgeon, at a minimum, seasonally use the nearshore coastal waters and could potentially be at risk from both coastal and offshore spills. As a result of the DWH event subsurface submerged oil mats were found (OSAT-2, 2011) in some subtidal nearshore waters. Depending on location and depth and toxicity of these submerged oil mats, Gulf sturgeon may potentially come in contact or ingest portions of these submerged oil mats while foraging. These submerged oil mats are normally found in very shallow water near beaches or shallow shorelines, which would not normally be considered as preferred habitat for Gulf sturgeon. The makeup of the submerged oil mats ranged from 83 to 90 percent sand with the weathered oil component ranging from 9 to 17 percent (OSAT-2, 2011). The degree of weathering, biodegradation, and high energy of the environment would all contribute to the lower toxicity of these submerged oil mats. As found in other beach sediments along the coast toxin level should not exceed USEPA's benchmarks for aquatic life (OSAT, 2010). Public data are not readily available at this time. In order to determine the toxicity of these submerged oil mats and therefore the threat to sturgeon, the current OSAT and OSAT -2 (2010 and 2011) results are utilized to hypothesize the potential for permanent impact to the sturgeon or its critical habitat. However, several factors influence the probability of spilled oil contacting Gulf sturgeon or their critical habitat. The likelihood of spill occurrence and subsequent contact with, or impact to, Gulf sturgeon and/or their designated critical habitat is extremely low. Based on the OSRA model for spills ≥1,000 bbl, there is a 1-2 percent and a 2-4 percent probability (after 10 and 30 days, respectively) of an oil spill occurring and contacting Gulf sturgeon critical habitat as a result of a CPA proposed action (**Figure 3-22**). **Chapters 3.2.1.6 and 3.2.1.7** describe the projections of future spill events in more detail.

If a large oil spill occurs, concentrations of oil below the slick could be within the ranges that cause sublethal effects on marine organisms. However, when exposure time to accidental spills, hydrocarbon composition, and the change in this composition during weathering are considered, exposure doses are assumed to be far less than doses reported to cause even sublethal effects (McAuliffe, 1987). Given the low probability that Gulf sturgeon would be present in the specific area where and when a spill occurs, small likelihood of contact of a surface oil slick with a demersal fish and its benthic habitat, and minimal concentrations of toxic oil relative to levels that would be toxic to adult or subadult Gulf sturgeon, the impacts of spilled oil on this endangered subspecies are expected to be low. With the DWH event, the oil was treated with dispersant, making the oil less toxic but causing the oil to sink and reach the benthic habitat. Normally, dispersants would be used in moderate amounts and only offshore so the benthic forage areas, as they are presently known and utilized by the sturgeon, would not be affected since the treated oil would sink in deepwater areas away from Gulf sturgeon nearshore habitats.

Regardless of spill size, the effects of direct contact from spilled oil on Gulf sturgeon occur through the ingestion of oil or oiled prey and the uptake of dissolved petroleum through the gills by adults and juveniles. Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon can result in mortality or sublethal physiological impacts, especially irritation of gill epithelium and disturbance of liver function. It is expected that the extent and severity of effects from oil spills would be lessened by active avoidance of oil spills by adult sturgeon. Sturgeons are demersal and would forage for benthic prey well below an oil slick on the surface. Adult sturgeon only venture out of the rivers into the marine waters of the Gulf for roughly 3 months during the coolest weather. This reduces the likelihood of sturgeon coming into contact with oil. It is expected that contact would cause sublethal irritation of gill epithelium and an increase in liver function for less than a month.

Based on currently available public information, it is reasonable to expect that oil production in the Gulf would continue to increase, although possibly at a slower rate due to economics of deepwater production and investment in other energy sources. In light of the DWH event and the impending cost of physical production modifications, regulations and safety requirements that may be needed to obtain a deepwater lease may reduce or temporarily delay the number of deepwater leases in production. This may have the effect of increasing shallow-water production, which could potentially result in adding a larger cumulative number of facilities closer to nearshore sturgeon habitat. If this happens, the potential for larger accidental spills closer to Gulf sturgeon critical habitat is possible. Currently, the toxicity, quantity, and surface and subsurface extent of the oil released during the DWH event is unknown until the NRDA process is completed and made available.

Dredging, Channelization, and Dredged Material Disposal

Dredge-and-fill activities occur throughout the nearshore areas of the United States. These activities range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation and coastal restoration projects. There will be a continual need for sand mining in coastal waters as a result of hurricane protection and coastal restoration projects. These activities, along with other non-OCS activities such as riverine sand and gravel operations and construction of emergency berms for the prevention of beach and marsh oiling (DWH event), indirectly impact Gulf sturgeon through the loss or disturbance of inland spawning and nearshore nursery habitat. Maintenance dredging and disposal to maintain navigation channels will continue to occur within Gulf sturgeon critical habitat (navigation channels are exempt from critical habitat) and may remove or modify foraging habitat as well as injure or kill some life history stages of the sturgeon. Hydraulic and mechanical dredging can lethally harm or kill various life stages of Gulf sturgeon. Of the three dredge types (hopper, clam, and pipeline); the hopper captured the most sturgeon (USDOI, FWS and USDOC, NMFS, 2009). The hopper dredges entrain young sturgeon either through the drag arm or the impeller pumps. Potential impacts from hydraulic dredge operations may be avoided by imposing work restrictions during sensitive sturgeon life history time periods (i.e., spawning, migration, staging, and feeding), as this is when sturgeon are most vulnerable to mortalities from dredging activity.

Dredged material disposal can be used beneficially for wetland restoration or creation, therefore eliminating the covering of important benthic feeding areas or fringe wetlands. Depending on the time of year, dredging can potentially entrain eggs, larvae, or postlarval sturgeon within the coastal rivers or near the river mouths. A CPA proposed action would not require dredging near natal rivers used as migratory routes to upstream spawning areas. While there could be a need for maintenance dredging in the nearshore waters, juvenile or adult sturgeon using these areas have the ability to avoid the dredging activity. The construction and maintenance of navigation channels is regulated by COE, and dredging permits are “conditioned” to avoid and minimize impacts to Gulf sturgeon and their critical habitat. These conditioned permits are coordinated with either FWS or NMFS or both, depending on the origin of the dredging operation.

Hurricanes and Other Natural Catastrophes

Natural catastrophes including storms, floods, droughts, and hurricanes can result in substantial habitat damage. Studies by McLelland and Heard (2004 and 2005) demonstrated that the benthic forage base in the Choctawhatchee Bay was damaged and changed in composition as a result of the difference in sediment composition and nutrient loading caused by Hurricane Ivan (2004). This lack of habitat caused

Gulf sturgeon to temporarily abandon this feeding area. Parauka (official communication, 2007a and 2008) noted an absence of Gulf sturgeon following Hurricanes Katrina and Rita (2005) in the Santa Rosa Sound. Further sampling indicated that the fish had moved to the Mobile Bay area but did return to the original Santa Rosa location within 1 to 1.5 years. In an interview after Hurricane Gustav (2008), Parauka (official communication 2008) explained that Gulf sturgeon were not only returning to Santa Rosa Sound but migrating between Mississippi Sound and Santa Rosa Sound.

Loss of habitat is expected to have a substantial effect on the reestablishment and growth of Gulf sturgeon populations. Natural phenomenon such as tropical storms and hurricanes will continue to occur along the Gulf Coast with varying frequency and intensity between years. Although these are usually localized and sporadic, the 2005 and 2008 hurricane seasons brought major and repeated damage to the Gulf Coast area. The effects from Hurricane Katrina (2005) are still being assessed. As a result of Hurricanes Katrina and Rita (2005) and Hurricanes Gustav and Ike (2008), sampling in the western portion of the range in Louisiana and Mississippi has been sparse. However, new studies to survey the Pearl River for Gulf sturgeon and to track its movements began in summer 2009 (USDOI, FWS and USDOC, NMFS, 2009). It was noted that Hurricanes Gustav and Ike did initially displace some of the Gulf sturgeon in the Mississippi-Louisiana area, much like what happened in Florida during Hurricane Katrina. Current surveys along the Mississippi coast indicate no permanent impact to critical habitat, and Parauka (official communication, 2007 and 2008) acknowledged that the sturgeons have returned to their normal feeding and resting areas along the coastal rivers. Sampling is not yet complete to see if the population has had any change in composition or if spawning has occurred (Slack, official communication, 2008). The hurricane impacts have not yet been fully assessed for Gulf sturgeon but they are generally believed to be temporary (Parauka, official communication, 2007).

The sturgeons are located upstream in freshwater riverine habitats during hurricane season. This may give the estuarine and marine areas time to recover from hurricane impacts before the sturgeon move downstream. For instance, massive runoff due to flooding rains and swollen tributaries could cause a sharp increase in toxic contaminants in estuarine habitats. Evaluations of water and sediment quality in Gulf sturgeon habitat on the northern Gulf of Mexico coast have consistently shown elevated pollutant loading. This has been observed in both tidal coastal rivers of the type that the sturgeon use in the spring and summer (Hemming et al., 2006 and 2008, as reported by USDOI, FWS and USDOC, NMFS 2009). Perhaps better understood is the widespread contamination throughout the overwintering feeding habitat of the Gulf sturgeon (USDOI, FWS and USDOC, NMFS, 2009). However, spreading and dilution should mitigate any threat to sturgeon quickly. By the time the downstream migration occurs, conditions should have returned to near normal.

Unpredicted drought events in the upper river basins are currently impacting some of the Gulf sturgeon’s riverine spawning habitat along the Apalachicola River in Florida. Recently, potential threats to the Gulf sturgeon’s habitat in the Apalachicola River system and the receiving bays have been raised as a consequence of reducing river flow to meet upstream water needs during drought conditions in Georgia. It is expected with the current predictions of climate change that there will continue to be cyclic drought conditions that will persist in various regions of the sturgeon’s range. This, combined with the increasing need for water from reservoirs in the urban areas north of the coast, will continue to be problematic for the conflicting needs for water.

Red tides are caused by toxic marine algae that occurs in the Gulf of Mexico and is distributed Gulfwide. These algae contain a brevetoxin that causes paralysis, intoxication, irregular swimming motions, loss of equilibrium, convulsions, and regurgitation, which normally ends in death as a result of respiratory failure. Since the 1990’s, the blooms of red tide have been increasing in frequency, with the most recent outbreak occurring in 2007 and another in 2008. Red tide was the probable cause of death for at least 20 Gulf sturgeons in Choctawhatchee Bay in 1999 (USDOI, FWS, 2000).

Changes in climate may continue to alter weather patterns such that persistent drought conditions may naturally or artificially (alter flow for reservoir maintenance) reduce river flow over critical riverine spawning habitat and, in turn, may displace spawning activities closer to the coastal waters, increasing the vulnerability of sturgeon larvae to coastal and inland spills. Changes in climate may also increase flooding frequency and intensity, adding large amounts of both nutrients and toxins into the estuary. Warmer water, sea-level rise, and higher salinity levels could lead to accelerated changes in habitats utilized by Gulf sturgeon. Changes in water temperature may alter the growth and life history of fishes, and even moderate changes can make a difference in distribution and number.

Commercial Fishing

Commercial fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may impact species other than the target species. For example, Gulf sturgeons are a small part of the shrimp bycatch. It is estimated that for every 1.1 lb (0.5 kg) of shrimp harvested, 8.8 lb (4 kg) of bycatch is discarded (Sports Fishing Institute, 1989). The death of several Gulf sturgeons is expected from commercial fishing. Commercial fishing is expected to continue; however, the Louisiana and Mississippi waters were closed to commercial fishing (including shrimp and oyster grounds) for 5 months as a result of the DWH event. In addition, increases in trawl density and successive trawling in one area may cause long-term impacts to the critical habitat.

Other Impact-Producing Factors

The cumulative and possibly repetitive effects of altering water flow in coastal rivers used by sturgeon for spawning may have long-term cumulative effects on the success of future spawning populations. Activities such as vessel traffic and OCS activities, runoff pollution, and dams can change water flow and quality in Gulf sturgeon habitats. Except for direct pipeline spills in the nearshore environment, the Gulf sturgeon would be at greater risk of a PAH encounter during the inland river migrations due to the industrial and farm waste introduced into these coastal rivers from the adjacent agricultural and urban land use. An example of impacts from an industrial spill is the fish kill that was a result of the Bogalusa Paperboard Mill discharging a byproduct of the papermaking process into the Pearl River during a plant malfunction in August 2011.

Vessel traffic would generally only pose a risk to Gulf sturgeon when vessels are leaving and returning to port. Major navigation channels are excluded from critical habitat. The Gulf sturgeon's characteristics of bottom-feeding and general avoidance of disturbance make the probability of vessel strike extremely remote. The explosive removal of structures as a result of a CPA proposed action would occur far offshore of Gulf sturgeon critical habitat and the riverine, estuarine, and shallow Gulf habitats where sturgeon are generally located. Environmental permit requirements and recent techniques for locating pipelines would result in very minimal impact to the Gulf sturgeon's critical habitat if any pipeline is installed nearshore as a result of a CPA proposed action.

Critical habitat along the Pearl River in Louisiana and portions of Mississippi has been recently subjected to an untreated paper mill effluent (August 9, 2011), resulting in the death of 23 Gulf sturgeon to date (Slack, official communication, 2011a). Since this species spends an extended portion of its life cycle in these inlands river habitats, exposure to these types of hazardous effluents is probable and will continue to be an additive cumulative effect. This spill has been classified as a biological rather than a chemical kill; therefore, recovery is expected to progress at a moderate pace once the effluent has moved through the area and is diluted by other incoming waters. The cumulative effect of these impacts and possibly others when combined with other environmental factors can considerably diminish the riverine spawning habitat for the Gulf sturgeon.

Access to historic Gulf sturgeon spawning habitat continues to be blocked by existing dams, and the ongoing operations of these dams also affect downstream habitat. Several new dams are being proposed that would increase these threats to the Gulf sturgeon and its habitat. Dams continue to impede access to upstream spawning areas and continue to adversely affect downstream habitat, including both spawning and foraging areas. The operation of the Federal reservoir in Georgia, which is controlled by COE, is affecting the spawning habitat of the Gulf sturgeon on the Apalachicola River in Florida. Two dams, Pools Bluff and Bogue Chitto Sills, also impact Gulf sturgeon movements in the Pearl River drainage. Upstream passage is likely possible over these structures during some flow conditions, but the extent to which passage occurs is still unknown. New studies to survey the Pearl River for Gulf sturgeon and to track their movements began in summer 2009 (Bolden, official communication, 2010). Additional dams will be likely constructed in the future and will include dams on the Pearl River in Mississippi, Escambia River in Alabama, and Yellow and Apalachicola Rivers in Florida (USDOI, FWS and USDOC, NMFS, 2009).

In addition, the currently proposed enlargement of coastal salt domes for use as oil-reserve storage will compromise flows in natal spawning rivers, as well as potentially increase salinity in the nearshore estuaries and bays (USDOI, FWS and USDOC, NMFS, 2009). As proposed, large amounts of freshwater will be removed from coastal rivers currently used by Gulf sturgeon and will be used to hydraulically mine the salt domes, producing a hypersaline effluent that will be piped to the coastal waters.

Summary and Conclusion

The Gulf sturgeon and its critical habitat can be cumulatively impacted by activities such as oil spills, dredging, natural catastrophes, commercial fishing, and other factors that can result in changes to habitats. The effects from contact with spilled oil would be sublethal and last for less than 1 month (Berg, 2006). Currently, there is little public data to ascertain the short-term and long-term effects of the DWH event on Gulf sturgeon or its critical habitat. It can be said that the critical habitat was exposed to oil and could possibly have been repeatedly exposed to oil in some cases. Until information is available on the quantity, type, and toxicity of the oil and where its spatial subsurface location is, no assessment can be made to the benthic forage base of the Gulf sturgeon. In addition, the oil underwent evaporation and was quickly emulsified and diluted at the wellhead by dispersants, which made it readily available for biodegradation. Because of the low probability of an offshore oil spill from a CPA proposed action occurring and contacting Gulf sturgeon critical habitat (≤4%; **Figure 3-22**), Gulf sturgeon contact with oil is expected to be minimal. The amount of oil projected to spill with a coastal spill is small, and it would have localized effects. A CPA proposed action would not require dredging near natal rivers used as migratory routes to upstream spawning areas. While there could be a need for maintenance dredging in the nearshore waters, juvenile or adult sturgeon using these areas have the ability to avoid the regulated dredging activity. Deaths of adult sturgeon are expected to occur from commercial fishing. Substantial damage to Gulf sturgeon critical habitat is expected from inshore alteration activities and natural catastrophes. As a result, it is expected that the Gulf sturgeon would experience a decline in population sizes and a displacement from their current distribution that would last more than one generation.

As noted above, BOEM acknowledges that there remains incomplete or unavailable information on Gulf sturgeon, including potential impacts from the DWH event (and thus changes to the Gulf sturgeon baseline in the affected environment). This makes an understanding of the affected environment and cumulative impacts less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to Gulf sturgeon. Relevant data on the status of Gulf sturgeon populations after the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis (including data on related fish species such as the Caspian Sea sturgeon) and applied this information based upon accepted scientific methods and approaches. Nevertheless, BOEM believes that this incomplete or unavailable information regarding the effects of the DWH event on Gulf sturgeon is likely not essential to a reasoned choice among alternatives when considering cumulative impacts. Non-OCS Program-related impacts are seen as the primary cumulative impacts on this resource, compared with a CPA proposed action, even in light of incomplete or unavailable information.

The incremental contribution of a CPA proposed action to the cumulative impacts on Gulf sturgeon is negligible. This is because the effect of contact between sale-specific oil spills and Gulf sturgeon is expected to be sublethal and usually last less than 1 month, and regulations and mitigations decrease impacts from routine events. Other non-OCS Program-related activities, including storms and anthropogenic factors on habitat, are expected to result in more cumulative impacts to this species.

4.2.1.18. Fish Resources and Essential Fish Habitat

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action’s incremental contribution to the cumulative impacts are presented in **Chapters 4.2.1.18.2 and 4.2.1.18.3**. A brief summary of potential impacts follows. Fish resources and EFH could be impacted by coastal environmental degradation, marine environmental degradation, pipeline trenching, and offshore discharges of drilling discharges and produced waters associated with routine activities. The impact of coastal and marine environmental degradation from OCS activities is expected to cause an undetectable decrease in fish resources or in EFH. Impacts of routine discharges are localized in time and space, are regulated by USEPA permits, and would have minimal impact. Accidental events that could impact fish resources and EFH include blowouts and oil or chemical spills. A subsurface gas blowout would have a negligible effect on Gulf of Mexico fish resources because the probability of the event is low and would affect a small portion of fish populations. Oil blowouts are discussed in **Chapter 4.2.1.18.3**. If spills due to a CPA proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish to avoid a spill.

Impact-producing factors of the cumulative scenario that are expected to substantially affect fish resources and EFH include coastal and marine environmental degradation, overfishing, and to a lesser degree, coastal petroleum spills and coastal pipeline trenching. At the estimated level of cumulative impact, the resultant influence of a CPA proposed action on fish resources and EFH is not expected to be easily distinguished from effects due to natural population variations. The incremental contribution of a CPA proposed action to the cumulative impacts on fisheries and EFH would be small.

4.2.1.18.1. Description of the Affected Environment

A detailed description of the fish resources of the Gulf of Mexico including ichthyoplankton, demersal species, pelagic species, and EFH can be found in **Chapter 4.1.1.15.1**.

The Gulf of Mexico supports a great diversity of fish. Distribution of fish species are related to variable ecological factors that include salinity, primary productivity, and bottom type. These factors differ widely across the Gulf of Mexico and between the inshore and offshore waters. Characteristic fish resources are associated with the various environments and are not randomly distributed. Major gradients include rainfall and river output, bottom composition, and depth. High densities of fish resources are associated with particular habitat types. Most finfish resources are linked both directly and indirectly to the vast estuaries that ring the Gulf of Mexico. Estuaries serve as nursery grounds for a large number of marine fishes that live on the inner continental shelves, such as the anchovies, herrings, mojarras, and drums. The EFH regulations (50 CFR 600) require NMFS to describe and identify habitats determined to be EFH for each life stage of each managed species. A large portion of the GOM is designated EFH because of the number of managed species and their different life history stages and the variety of habitats in the GOM. Because of the variety of habitats, almost the entire GOM is designated as EFH. The CPA also has some limited areas of smaller carbonate features, often referred to as pinnacles offshore, Mississippi and Alabama. There are thousands of these carbonate mounds or pinnacles (live-bottom/low-relief features) dotting the OCS of Mississippi/Alabama. They share many characteristics of patch reefs found in shallow tropical areas. The mounds are discrete, vary in size and structural complexity, and are surrounded by level sediment bottoms. The fish community associated with pinnacles is summarized in Snyder (2001). This 4-year project investigated pinnacle features ranging in depths between 60 and 90 m (197 and 295 ft). This fish assemblage is much less diverse than the reef fish assemblages reported for water depths <50 m (164 ft), but it is distinctive in its species composition and is characterized by the presence of a core group of deep reef forms including roughtongue bass (*Pronotogrammus martinicensis*), wrasse basslet (*Liopropoma eukrines*), tattler (*Serranus phoebe*), short bigeye (*Pristigenys alta*), yellowtail reef fish (*Chromis enchrysura*), bank butterflyfish (*Chaetodon aya*), red barbier (*Hemanthias vivanus*), and scorpionfishes (*Scorpaena* spp). Additional information on this habitat also appears in **Chapter 4.2.1.6.** The remaining OCS shelf in the CPA, ranging to a depth of approximately 200 m (656 ft), generally has a muddy or silty soft bottom.

Commercial and recreational fish stocks managed by the Gulf of Mexico Fisheries Management Council are listed and categorized by habitat in **Appendix B**. Of those species managed, four are listed as overfished (USDOC, NMFS, 2011e): gag grouper (*Mycteroperca microleptis*); greater amberjack (*Seriola dumerili*); red snapper (*Lutjanus campechanus*); and gray triggerfish (*Balistes capriscus*). An overfished stock has a biomass level below its prescribed biological threshold or its population size is too low. Annual catch limits were required to be in place for all stocks subject to overfishing since 2010 by the Reauthorization Act of 2006. These species are discussed in C**hapters 4.2.1.19.1 and 4.2.1.20.1**. Recently, hurricanes have been a prominent impacting factor to Gulf resources and have affected fish resources by destroying oyster reef habitats and by changing physical characteristics of inshore and offshore ecosystems. The intense hurricane season of 2005, including Hurricanes Katrina and Rita, did not affect the offshore fisheries as much as initially expected. By far, the worst resource devastation that occurred was for oyster populations (USDOC, NMFS, 2007a). In September 2008, Hurricanes Gustav and Ike made landfall on the Gulf Coast. Hurricane Gustav came ashore southwest of New Orleans as a

Category 2 storm, and Hurricane Ike made landfall as a Category 2 storm at Galveston, Texas. In April 2009, the Louisiana Dept. of Wildlife and Fisheries announced a $15.7 million cooperative research program with NMFS to monitor the recovery of Louisiana commercial fisheries impacted by Hurricanes Katrina, Rita, Gustav, and Ike (Louisiana Dept. of Wildlife and Fisheries, 2009). Caffey (official communication, 2009) estimated revenue losses from Hurricanes Gustav and Ike on Louisiana fisheries and aquaculture sectors in excess of $98 million. The NMFS landings data show a drop in finfish harvest in both Louisiana and Texas, an increase in shrimp harvest in Texas, and a drop in shrimp harvest in Louisiana (USDOC, NMFS, 2008). This may be due to the loss of boats and infrastructure.

In September 2008, the Louisiana Dept. of Wildlife and Fisheries (2008a and 2008b) released preliminary, nonquantitative reports of the effects of Hurricanes Gustav and Ike on Louisiana fisheries. In it, they noted the extensive marsh erosion and vegetative debris present in the canals of southeastern Louisiana, as well as localized fish kills, loss of marsh through erosion, and displacement and encroachment of saltwater into freshwater areas, a contributor to loss of essential fish habitat.

The DWH event in Mississippi Canyon Block 252, southeast of Venice, Louisiana, introduced large quantities of oil into the water column between the spill site and the marshes of the central Gulf Coast during the spring and summer of 2010. Oil from this incident has been observed to contact shorelines from Galveston, Texas, to Apalachicola, Florida, with the primary areas of oiling occurring from Grand Isle, Louisiana, west of the mouth of the Mississippi River to Santa Rosa Island, Florida. The oil penetrated estuaries at least along the Louisiana and Mississippi coasts and was driven farther inshore by the passage of Hurricane Alex, which made landfall near the Texas/Mexico border. The potential oiling footprint as reported through the National Oceanic and Atmospheric Administration's ERMA (posted on the GeoPlatform.gov website) did not indicate oil in the surface waters of the WPA (USDOC, NOAA, 2011b). The oil was concentrated in the CPA, and oil that migrated west in the CPA was primarily observed close to Louisiana's Gulf Coast. Although Shoreline Cleanup Assessment Teams (SCAT) did not sample Texas beaches, there was one confirmation of tarballs from the DWH event washing up on Bolivar Peninsula and Galveston Island, Texas (USDOC, NOAA 2010f and 2011b; RestoreTheGulf.gov, 2010a). The oil was lightly weathered and likely did not travel to the beaches from the source of the spill (RestoreTheGulf.gov, 2010a). It is more likely that the oil reached Texas beaches through transport by a response vessel (RestoreTheGulf.gov, 2010a). Because the tarballs were likely transported to the WPA by vessel and not through currents, the soft-bottom benthic communities in the WPA are not anticipated to be impacted by the localized report of oil.

All of these estuaries are extremely important nursery areas (EFH) for fish and aquatic life (Bahr et al., 1982). Oiling of these areas, depending on the severity, can destroy nutrient-rich marshes and erode coastlines, adding to the destruction caused by the recent hurricanes.

Early life stages of animals are usually more sensitive to environmental stress than adults (Moore and Dwyer, 1974). Oil can be lethal to fish, especially in larval and egg stages, depending on the time of the year that the event happened. Weathered crude oil has been shown in laboratory experiments to cause malformation, genetic damage, and even mortality at low levels in fish embryos of Pacific herring (Carls et al., 1998). Hernandez et al. (2010) recently studied seasonality in ichthyoplankton abundance and assemblage composition in the northern GOM off of Alabama. They found larvae representing 58 different families. Fish egg abundance, total larval abundance, and taxonomic diversity were significantly related to water temperature, not salinity, with peaks in spring, spring-summer, and summer. Detailed analyses of ichthyoplankton are not available east of this single sampling station or west of it closer to the spill area. The patterns found in this study do indicate, however, that a possible mortality occurred in the larval fishes of the Gulf that came in contact with the spilled oil, depending on the timing of the spawn and the area influenced by the spill.

In general, most reef fishes are associated with habitats on the continental shelf inshore of the spill. Most of these fish spawn during spring/summer and the larvae may be at risk, affecting recruitment in future age classes. Surface feeders as menhaden and inhabitants of seagrass beds may be at risk depending on whether the oil floats or sinks. Sharks are commonly found Gulfwide in nearshore and offshore waters. Blacktip sharks and bull sharks are often found in estuaries Gulfwide and may be at risk, along with other estuarine species depending on the extent of the penetration of the oil into the estuaries.

During June 2010, whale sharks were sighted surface filter feeding in heavy oil 4 mi (6 km) from the spill site (Mulvaney, 2010). These large, migratory sharks have been documented to use the waters of the northern Gulf of Mexico, specifically water in close proximity of the Mississippi River Delta, as essential feeding habitat during the summer (Hoffmayer et al., 2005). In addition, tagging data have shown that these sharks are far ranging, with some individuals tracked as far away as Belize and Honduras. They are surface feeders, filtering plankton and tiny fish through their mouths. Oil poses a threat to their prey, but also, if directly ingested, oil could coat their gills (Hoffmayer, official communication, 2011).

Of particular concern are Gulf populations of Atlantic bluefin tuna. The occurrence of Atlantic bluefin tuna larvae associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that these species spawn in the GOM (Richards, 1990). Block et al. (2001) also reported on the GOM being used as a breeding ground and demonstrated trans-Atlantic migrations of Atlantic bluefin tuna between the eastern Mediterranean, Atlantic, and GOM using electronic data storage tags. The North Atlantic bluefin tuna are known to spawn in April to June in the Gulf (Teo et al., 2007a).

The Western Atlantic stock has suffered a significant decline in spawning stock biomass since 1950, and a 20-year rebuilding plan has failed to revive the population or the North American fishery. The failure of the Gulf of Mexico spawning population to rebuild, as well as the scope of illegal and under-reported catches, particularly in the Mediterranean Sea, are of such major concern that the species was recently considered by the Convention for International Trade in Endangered Species for endangered species listing in March 2010. More recently, as a result of a petition by the Center for Biological Diversity, NMFS also considered listing Atlantic bluefin tuna as endangered or threatened under the Endangered Species Act. On May 27, 2011, after extensive review, NMFS announced that the Atlantic bluefin tuna did not warrant species protection under the ESA. The NMFS has, however, committed to review this decision in early 2013 based on a Stock Assessment to be completed in 2012 and pending more information on the DWH event (*Federal Register*, 2011c).

Because of their decline in stock, the timing of their spawn in the Gulf, their buoyant eggs, and the timing of the DWH event, there is concern about further decline in the Gulf stock of Atlantic bluefin tuna. The effects at this time are, however, unknown. A recent analysis for NOAA using two independent computer models concluded that there is likely less than a 4 percent reduction in the future breeding stocks of the bluefin tuna (Atlantic Bluefin Status Review Team, 2011)

Thus far, only anecdotal (observational) evidence is available concerning fish kills. Recent analysis of early stage survival of fish species inhabiting seagrass nursery habitat from Chandeleur Islands, Louisiana, to St. Joseph Bay, Florida, pre- and post-DWH, show that immediate catastrophic losses of 2010 cohorts were largely avoided and no shifts in species composition occurred following the spill (Fodrie and Heck, 2011).

Offshore, a few small fish kills very near the spill site have been reported. On the shelf and inshore also, a few, small fish kills have been reported that included common inshore species such as Atlantic croaker, anchovy, and menhaden. Fish kills such as these are common in shallow, Gulf Coast estuaries that often become devoid of oxygen in areas in the summer.

The total impacts of the spill on ichthyoplankton and fish populations of the CPA are mostly speculative at this time. The use of dispersants compounds the uncertainties. Although COREXIT 9500, the dispersant used for the DWH event, is believed to be the least effective toxic of all of its counterparts to small fish, its toxicity, when mixed with oil, is unknown to specific species of ichthyoplankton, juvenile, and adult fish. In July 2010, USEPA and NOAA proposed a monitoring program that will assess the toxicity of 20:1 oil/COREXIT to Atlantic silversides.

The addition of COREXIT 9500 at the seafloor spill site and the surface resulted in the dispersion of oil in the water column. The addition of any carbon source such as oil can decrease dissolved oxygen due to microbial breakdown, and it was a particular concern during the DWH event due to the use of dispersants (**Chapter 4.2.1.2.1.1**). In areas where plumes of dispersed oil were previously found, dissolved oxygen levels decreased by about 20 percent from long-term average values in the GOM; however, scientists reported that these levels have stabilized and are not low enough to be considered hypoxic (USDOC, NOAA, 2010t). The drop in oxygen, which has not continued over time, has been attributed to microbial degradation of the gas and oil.

Methane gas (CH_4) is commonly found in the Gulf of Mexico in concentrations of 6 x 10^{-5} ml/L to 125 x 10^{-5} ml/L in the Gulf of Mexico (Frank et al., 1970). At their baseline levels, methane levels are controlled by methanotrophs (methane degrading bacteria) (Patin, 1999). Patin (1999) reported elevated concentrations of methane, resulting from gas blowouts from drilling platforms in the Sea of Asov, resulted in significant species-specific pathological changes including damages to cell membranes, organs and tissues, modifications of protein synthesis, and other anomalies typical for the acute poisoning of fish. These impacts, however, were observed at levels of .4-6 mg/L (ppm) near the well. Typical methane concentrations observed by Kessler and Joye during the DWH spill were significantly lower than the levels in the Patin study with highest concentrations observed only in the subsea (>799 m; 2,621 ft) near the wellhead (Valentine, official communication, 2010).

Recently published research (Kessler et al., 2011) revealed that a large amount of methane was released by the during the DWH event and, based upon the methane and oxygen distributions measured at 207 stations in the affected area, a large amount of oxygen was respired by methanotrophs. Kessler et al. (2011) suggest that the methane triggered a large methanotroph bloom that rapidly degraded the methane, leaving behind a residual methanotrophic community.

How assemblages of fish have changed or will change as a result of the DWH event is unknown at this time. The specific effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes (internal lesions), effects of direct coating by oil (suffocation by coating gills), incorporation of hydrocarbons in organisms causing tainting or accumulation in the food chain, and changes in biological habitat (Moore and Dwyer, 1974).

Adult fish tend to avoid contact with areas of low dissolved oxygen in the water column (Wannamaker and Rice, 2000). The Mississippi State Extension Service (2011) published a report stating that anglers recently reported and documented lesions on fish that they are catching in the Federal waters off Alabama. The report further states that LSU scientists determined the lesions on red snapper were infected with *Vibrio vulnificus* and *Photobacteria damselae.* These fish may pose a health risk if eaten raw. Dr. James Cowan at LSU's Department of Oceanography and Coastal Sciences said that the reports of sick fish correlate with areas most impacted by the DWH event. Dr. Cowan verified this report on June 23, 2011, in a written communication (Cowan, official communication, 2011). A broader survey is planned to determine whether the areas of sick fish extend beyond Alabama's coastal waters (Mississippi State Extension Service (2011).

The severity and the duration of the effects of all of these factors on the fish assemblages and fisheries of the Gulf of Mexico are largely speculative at this time. No evidence of significant impacts to fisheries populations in the Gulf of Mexico have been shown to date.

It is unlikely that this information will be available within the timeframe contemplated by this NEPA analysis, even if the resources were available to undertake these studies. It is also difficult to gather reliable population information on all species, including highly migratory species, and it is difficult to distinguish between population variabilities due to the spill as opposed to population variabilities due to other naturally occurring environmental factors. Therefore, in the impacts analysis below, credible scientific information that is available on the impacts to the species has been applied using accepted methodologies. In any event, although this information is currently unavailable, it is not essential to a reasoned choice among alternatives because the fish in the area of the CPA affected by the spill are mobile and most would likely have moved away from the area immediately affected by the spill.

Nevertheless, information on the effects of the DWH event on fisheries is incomplete at this time and may take years to obtain and analyze. This information will be developed through the NRDA process, is not expected to be complete or released to the public for years, and will certainly not be available during the timeline of this EIS. Regardless of cost, it is not within BOEM's ability to obtain this information from the ongoing NRDA process. This information may be relevant to reasonably foreseeable significant impacts, and BOEM cannot definitively state at the present time whether this information may be essential to a reasoned choice among alternatives. The BOEM subject-matter experts, however, have used the scientifically credible information that is available and applied it using accepted scientific methodologies.

Essential Fish Habitat

Essential fish habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, and growing to maturity. The HAPC's are localized areas of EFH that are ecologically important, sensitive, stressed, and/or rare areas as compared with the rest of a species EFH geological range. Examples of HAPC, as designated by GMFMC in the vicinity of the CPA, are portions of the Flower Garden Banks. The NMFS has a poster outlining many of these banks; it can be found on their website (GMFMC, 2006b). The GOM waters out to 100 fathoms (182 m; 600 ft) have EFH's described and identified for managed species (GMFMC, 2005; USDOC, NOAA, 2009). There are FMP's for shrimp, red drum, reef fishes, coastal migratory pelagics, spiny lobsters, coral and coral reefs, and highly migratory species (GMFMC, 2004; USDOC, NOAA, 2009). These species could use the GOM for EFH at different life history stages. The Highly Migratory Species Fisheries Management Plan was recently amended to update EFH and HAPC's for the Atlantic bluefin tuna spawning area (USDOC, NOAA, 2009).

These EFH's in the CPA are discussed in various sections of this EIS: water column (**Chapter 4.2.1.2**); wetlands (**Chapter 4.2.1.4**); seagrass communities (**Chapter 4.2.1.5**); live bottoms (pinnacle trend/low relief) (**Chapter 4.2.1.6**); topographic features (**Chapter 4.2.1.7**); *Sargassum* (**Chapter 4.2.1.8**); chemosynthetic deepwater benthic communities (**Chapter 4.2.1.9**); nonchemosynthetic deepwater benthic communities (**Chapter 4.2.1.10**); and soft-bottom benthic communities (**Chapter 4.2.1.11**); they are also summarized in **Appendix D**. There are current NTL's (NTL 2009-G39 and NTL 2009-G40) and stipulations that provide guidance and clarification of the regulations with respect to many of these biologically sensitive underwater features and areas and benthic communities, which are considered EFH (USDOI, MMS, 2009a and 2009b). These are summarized in **Chapters 2.4.1.3.1 and 2.4.1.3.2,** and **Appendix D**.

Federal agencies must consult with NMFS for any actions authorized, funded, or undertaken; or proposed to be authorized, funded, or undertaken that may adversely affect EFH. As a Federal agency proposing future activities that may impact EFH, an EFH Assessment is required. The requirements for an EFH description and assessment are as follows: (1) description of a CPA proposed action; (2) description of the action agency's approach to protection of EFH and proposed mitigation, if applicable; (3) description of EFH and managed and associated species in the vicinity of a CPA proposed action; and (4) analysis of the effects of the proposed and cumulative actions on EFH, the managed species, and associated species. The BOEMRE entered into a Programmatic Consultation agreement with NMFS on July 1, 1999, for petroleum development activities in the CPA. Following the DWH event on July 30, 2010, BOEMRE requested reinitiation of ESA consultation with both NMFS and FWS. The NMFS responded with a letter to BOEMRE on September 24, 2010. The EFH consultation was also addressed in the NMFS letter. A new EFH consultation has been initiated between BOEM's Gulf of Mexico OCS Region and NMFS's Southeast Region. An EFH assessment that includes summaries of a CPA proposed action, impacts, and relevant NTL's; descriptions of managed species and EFH's; and the recommendations from NMFS with the responses from BOEM can be found in **Appendix D**. The BOEM will continue to comply with all reasonable and prudent measures and the terms and conditions under the existing consultations, along with implementing the current BOEM-imposed mitigation, monitoring, and reporting requirements. Based on the most recent and best available information at the time, BOEM will also continue to closely evaluate and assess risks to listed species and designated critical habitat in upcoming environmental compliance documentation under NEPA and other statutes.

The GMFMC's *Generic Amendment for Addressing Essential Fish Habitat Requirements* (GMFMC, 1998) identifies threats to EFH and makes a number of general and specific habitat preservation recommendations for pipelines and oil and gas exploration and production activities within State waters and OCS areas. The *Generic Amendment* (GMFMC, 1998) also lists a number of measures that may be recommended in association with exploration and the production activities located close to hard banks and banks containing reef-building coral on the continental shelf. Finally, the most recent Generic Amendment 3 (GMFMC, 2005) also included comments regarding oil and gas exploration and production activities on the continental shelf. These changes and recommendations are addressed by BOEM and are incorporated into the permitting process with the NTL guidelines and stipulations. Compliance with stipulations from lease sales is not optional; application of a stipulation(s) is a condition of the lease. In addition, BOEM may attach mitigating measures to an application (e.g., exploration, drilling, development, production, pipeline) and issue an NTL.

Individual States, COE, and USEPA have review and permit authority over oil and gas development and production within State waters. All oil and gas activities in coastal or wetland areas must adhere to numerous conservation measures before receiving permits from these agencies. In order to minimize potential coastal impacts from OCS-related activities, BSEE has numerous safety, inspection, and spill-response requirements in place to prevent an accidental release of hydrocarbons from either happening at all or from reaching land (**Chapters 1.3.1 and 1.5**).

4.2.1.18.2. Impacts of Routine Events

Background/Introduction

Effects on fish resources and EFH from routine activities associated with a CPA proposed action could result from coastal environmental degradation, marine environmental degradation, pipeline trenching, and offshore discharges of drilling muds and produced waters. The effects from these routine activities on the different EFH's that are discussed in this EIS are summarized in **Appendix D**. Since the majority of fish species within the CPA are estuary dependent, coastal environmental degradation resulting from a CPA proposed action has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Chapters 4.2.1.4.2 and 4.2.1.5.2 consider the effects from routine activities associated with a CPA proposed action on estuarine habitats such as wetlands and seagrass communities. These activities include the construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, and inshore disposal of OCS-generated petroleum field wastes. Coastal and inshore water quality may be adversely affected by saltwater intrusion and sediment disturbances resulting from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash and discharges in association with OCS operations may also impact inshore water quality conditions. Water quality is monitored and regulated by USEPA and USCG; this would limit the levels of toxins from routine activities.

Routine activities associated with a CPA proposed action could impact live bottoms such as the pinnacle trend and low relief (**Chapters 4.2.1.6.1.2 and 4.2.1.6.2.2**), topographic features (**Chapter 4.2.1.7.2**), deepwater benthic communities such as chemosynthetic and nonchemosynthetic (**Chapters 4.2.1.9.2 and 4.2.1.10.2**), soft-bottom communities (**Chapter 4.2.1.11.2**), and organisms colonizing scattered anthropogenic debris and artificial reefs. Routine activities include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, and pipeline trenching. Impacts could include the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible. Many of these areas are protected through "No Activity Zones" and other regulations within the leases and permits. Stipulations and guidelines to the regulations that are covered in NTL 2009-G39 and NTL 2009-G40 decrease the probabilities of impacts to these offshore communities. These are summarized in **Chapters 2.4.1.3.1 and 2.4.1.3.2 and Appendix D**.

Impact-producing factors from routine offshore activities that could result in offshore water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (**Chapter 4.2.1.2.2.2**). Coastal operations could indirectly affect marine water quality through the migration of contaminated coastal waters (**Chapter 4.2.1.2.1.2**). *Sargassum* could be affected by changes to water quality due to routine activities (**Chapter 4.2.1.8.2**) but, because of the ephemeral properties of the habitat and yearly life cycle of the algae, the effects are not expected to hinder the population. Water quality is highly regulated and monitored by USEPA and USCG, so toxins should remain limited.

Proposed Action Analysis

The adverse impacts from routine activities to estuaries and coastal water quality are called coastal environmental degradation in this EIS. The adverse impacts from routine activities to the offshore environment and water quality are called offshore environmental degradation in this EIS.

Coastal Environmental Degradation

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A small amount of the routine dredging done in coastal areas could be a direct or indirect consequence of a CPA proposed action. Some resuspension of bottom contaminants would be realized during dredging operations, although very little would be soluble in the water column and in bioavailable form. Many of these activities are regulated and mitigated through COE and State permits, so coastal environmental degradation from a CPA proposed action would have little effect on fish resources or EFH. Recovery of fish resources or EFH can occur from most of the potential coastal environmental degradation. Because of the high fecundity of many species associated with coastal habitats populations, if left undisturbed they will regenerate quickly. At the expected level of effects on the coastal environment (EFH), the resultant influence on fish resources from a CPA proposed action would be negligible and indistinguishable from natural population variations (e.g., year-class abundance shifts from changes in climate or water current patterns).

Offshore Environmental Degradation

The projected length of pipeline installations for a CPA proposed action (a typical sale) is 628-1,870 km (390-1162 mi) for all water depths (**Table 3-3**). Trenching for pipeline burial has the potential to adversely affect fish resources by disturbing the shelf bottom and by increasing turbidity in close proximity to the pipeline activity. Any affected population is expected to avoid areas of excessive areas of turbidity because the population's typical behavior is to avoid any adverse conditions in water quality. At the expected level of impact, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations.

The projected total number of production structure installations resulting from a CPA proposed action for all water depths is 35-67 (**Table 3-3**). Bottom disturbance from structure emplacement operations associated with a CPA proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants. Structure emplacements can act as fish-attracting devices and can result in aggregation of migratory and reef fish species. This is likely to occur to some degree with these structures in the CPA. A number of commercially important species, such as tunas and marlins, are known to congregate around fish-attracting devices. Almost immediately after a platform is installed, the structure would be acting as an artificial reef. After just a few years, many of the fish species present would be residents and not new transients. Reef-building corals and other species such as black corals have also been documented colonizing numerous platforms (Sammarco et al., 2004; Boland and Sammarco, 2005).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within 1 year of lease relinquishment or termination of production. Seventy percent of the platforms in water depths <200 m (656 ft) are removed by severing their pilings with explosives placed 5 m (16 ft) below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). Most multi-leg platforms in water depths <156 m (512 ft) are removed by severing their pilings with explosives placed 5 m (15 ft) below the seafloor. It is projected that 31-60 structures in water depths <200 m (656 ft) in the CPA would be removed and 20-40 of these would be removed using explosives as a result of a CPA proposed action (**Table 3-3**). Structure removal results in artificial habitat loss. It is expected that structure removals would have a negligible effect on fish resources because these activities kill only those fish that are in close proximity to the removal site and that do not leave the area; therefore, impacts would be limited in geographic scope and not rise to any population-level impacts across the CPA or Gulf of Mexico generally.

The major sources of routine discharges to marine waters associated with a CPA proposed action are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Drilling mud contains materials, such as lead, mercury, and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m (3,281 ft), and is usually undetectable at distances >3,000 m (9,843 ft) (Kennicutt, 1995). Since 1993, USEPA has required concentrations of mercury and cadmium to be ≤1 ppm and 3 ppm, respectively, in the stock barite used to make drilling mud. The toxicity of the metals associated with drilling muds also depends upon their bioavailability to organisms. Methylmercury is the bioavailable form of mercury (Trefry and Smith, 2003). In a study of methylmercury in sediments surrounding six offshore drilling sites, it was found that methylmercury concentrations did not vary significantly between near-field and far-field sites (Trefry et al., 2003). Further, the study suggested that levels of methylmercury in sediments around drilling sites are not a widespread phenomenon in the GOM (Trefry et al., 2003). Therefore, it appears that methylmercury concentrations near OCS activities are not significantly different from background levels in the Gulf of

Mexico. The discharge of drilling muds is, therefore, not anticipated to contribute to fish mortality either through direct exposure to discharged drilling muds or resuspension of muds through wave action or dredging.

Produced waters discharged offshore contain hydrocarbons and metals. In addition, they have components and properties such as hypersalinity and organic acids that have a potential to adversely affect fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m (3,281 ft) and are undetectable at a distance of 3,000 m (9,843 ft) from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995). Produced water has not been shown to cause fish mortality in populations surrounding platforms. Recent studies have suggested that the alkylphenols in produced water, when fed to Atlantic cod may have a detrimental effect on the reproductive fitness of cod populations (Meier et al., 2007) or may stimulate the immune systems of juvenile Atlantic cod, potentially resulting in an energetic cost that may be detrimental to the fish (Perez-Casanova et al., 2010). However, Holth et al. (2011) found through nondestructive testing that there were no apparent adverse effects of treatment of Atlantic cod with synthetic produced water.

Produced water dilutes rapidly after discharge and is usually discharged near the surface so that the dilution factor is maximized. The discharge of produced water is regulated by the U.S. Environmental Protection Agency's NPDES permits, and this ensures that water quality standards are upheld.

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but sublethal physiological irritation to fish resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question.

It is expected that marine environmental degradation from a CPA proposed action would have little effect on fish resources or EFH. The primary factors that affect fish populations as a result of the drilling operations discussed above have relatively minor impacts to fish resources. Fish resources are also highly variable and are distributed over a very large area in the GOM. It is often impossible to separate the natural population variability from any potential impact due to marine environmental degradation and decrease in fish populations. Recovery of fish resources or EFH can generally occur from the potential marine environmental degradation. Most fish populations, if left undisturbed, regenerate quickly because impacts to the habitat would generally be temporary; fish tend to avoid areas of impact (thus reducing mortality effects) and they are prolific reproducers. Fish populations, if left undisturbed, will regenerate quickly given the absence of catastrophic events. Live bottoms and topographic features are not expected to be impacted (**Chapters 4.2.1.6 and 4.2.1.7.2**).

Offshore discharges and subsequent changes to marine water quality would be regulated by the U.S. Environmental Protection Agency's NPDES permits. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

The Topographic Features and Live Bottom Stipulations are discussed in **Chapters 2.3.1.3.1, 2.4.1.3.1, and 2.4.1.3.2**. These stipulations are applied to all leases near topographic features and the pinnacle trend area to protect important fish and EFH habitat. The application of the guidelines outlined in NTL 2009-G39, "Potentially Sensitive Biological Features," would also serve to prevent impacts to hard-bottom EFH habitat associated with topographic features that may be outside previously defined No Activity Zones. The lease stipulation and NTL 2009-G39 protect sensitive EFH from both routine and accidental impacts that may occur during petroleum production. This stipulation and NTL, among other things, focus OCS activities at specified distances from the topographic features, a sensitive EFH, thereby increasing the distance between the features and their associated fish populations. For more information regarding stipulations related to fish resources and EFH, see **Appendix D**.

Summary and Conclusion

The BOEM has examined the analysis for impacts to fish resources and EFH based on the additional information presented above. It is expected that any possible coastal and marine environmental degradation from a CPA proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause a nondetectable decrease in fish resources or in EFH. Routine activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts that would not deleteriously affect fish resources or

EFH. This is because of regulations, mitigations, and practices that reduce the undesirable effects on coastal habitats from dredging and other construction activities. Permit requirements should ensure that pipeline routes either avoid different coastal habitat types or that certain techniques are used to decrease impacts. At the expected level of impact, the resultant influence on fish resources would cause minimal changes in fish populations or EFH. That is, if there are impacts, they would be short term and localized; therefore, they would only affect small portions of fish populations and selected areas of EFH. As a result, there would be little disturbance to fish resources or EFH. In deepwater areas, many of the EFH's are protected under stipulations and regulations currently set in place.

Without the mitigations in place, there could be major negative impacts to topographic features and live bottoms. However, some of the routine impact-producing factors are mitigated by BOEM through the Topographic Feature Stipulation and the Live Bottom (Pinnacle Trend and Low Relief) Stipulations. These stipulations establish a No Activity Zone around important topographic features such as the Flower Gardens Banks Reef and low-relief live bottoms, and NTL 2009-G39 and NTL 2009-G40 advise operators to avoid hard-bottom habitats that support fish populations. Much of coastal wetland loss that supports estuarine habitat and nursery grounds, on which fish stocks are dependent, is a result of inshore oil and gas extraction and not the result of offshore oil and gas leasing. Estuarine water quality degradation is largely a result of urban runoff. Offshore water quality is affected temporarily and in a limited area by the discharge of produced water and the overboard discharge of drill muds. Pipeline trenching, maintenance dredging, and canal widening in inshore areas causes only the temporary suspension of sediments. Negative impacts from most of these routine operations would require a short time for fish resources to recover. This is because of multiple life history and environmental factors such as fecundity or year-class recruitment through oceanographic circulation.

Additional hard-substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase fish populations or attract fish populations. The removal of these structures will eliminate that habitat, except when decommissioned platforms are used as artificial reef material. This practice is expected to increase over time.

For these reasons, as well as the fact that Gulf of Mexico fish stocks have retained both diversity and biomass throughout the years of offshore development, a CPA proposed action is expected to result in a minimal decrease in fish resources and/or standing stocks or in EFH.

4.2.1.18.3. Impacts of Accidental Events

Background/Introduction

Accidental events associated with a CPA proposed action that could impact fish resources and EFH include blowouts and oil or chemical spills. The EFH's that are covered throughout this EIS and that are affected by these possible accidents are water quality (**Chapters 4.2.1.2.1.3 and 4.2.1.2.2.3**), wetlands (**Chapter 4.2.1.4.3**), seagrass communities (**Chapter 4.2.1.5.3**), live bottoms (**Chapter 4.2.1.6.3**), topographic features (**Chapter 4.2.1.7.3**), *Sargassum* (**Chapter 4.2.1.8.3**), chemosynthetic deepwater benthic communities (**Chapter 4.2.1.9.3**), nonchemosynthetic deepwater benthic communities (**Chapter 4.2.1.10.3**), and soft-bottom benthic communities (**Chapter 4.2.1.11.3**). These events and the effects to EFH's are also summarized in **Appendix D**.

Blowout and Oil-Spill Impacts

Subsurface blowouts, although unlikely, have the potential to adversely affect fish resources. A blowout at the seafloor could create a crater and resuspend and disperse large quantities of bottom sediments. This potentially affects a limited number of resident and transient fish in the immediate area. The majority of mobile deep-sea benthic or near-bottom fish taxa would be expected to leave (and not reenter) the area of a blowout before being impacted by the localized area of resuspended sediments.

Resuspended sediments can clog fish gills and interfere with respiration for those fish that happen to be in the area at the time of the blowout. Settlement of resuspended sediments may directly smother deepwater invertebrates that serve as food sources. However, coarse sediment should be redeposited quickly within several hundred meters or feet of a blowout site. Finer sediments can be more widely dispersed and redeposited over a period of hours to days within a few thousand meters or feet depending on the particle size. Other fish not in the immediate area at the time of the blowout would be expected to avoid the impacted area based on their typical observed behavior to avoid adverse conditions. Ideally, the stipulations and guidance provided by BOEM with NTL 2009-G39 and NTL 2009-G40 would further decrease the potential and the effects of a blowout on offshore EFH's.

Gas blowouts consist mainly of methane, which rapidly dissolves in the water column or disperses upward into the air. These gas blowouts are less of an environmental risk. Loss of gas well control does not always release liquid hydrocarbons. The release of hydrocarbons with the gas is possible.

In the case of the DWH event (consisting of a combination of oil and gas), it has been suggested that the addition of dispersants at the seafloor has resulted in large subsurface clouds of elevated methane concentrations. These alleged areas of elevated methane concentrations may potentially result in areas of lowered dissolved oxygen concentrations due to the actions of methanotrophic bacteria. Literature on this subject is scarce, so little is really known about the effects of methane on fish. Methane gas (CH_4) is commonly found in the Gulf of Mexico in concentrations of 6 x10^{-5} ml/L to 125 x 10^{-5} ml/L in the Gulf of Mexico (Frank et al., 1970). Patin (1999) reported elevated concentrations of methane in the Sea of Asov resulting from gas blowouts from drilling platforms. He reported that these levels resulted in significant species specific pathological changes. These include damages to cell membranes, organs and tissues, modifications of protein synthesis, and other anomalies typical for acute poisoning of fish. However, these impacts were observed at levels of 1-10 ml/L, which is higher than the background levels in the Gulf of Mexico.

Recently published research (Kessler et al., 2011) revealed that a large amount of methane was released by the DWH event and, based upon the methane and oxygen distributions measured at 207 stations in the affected area, a large amount of oxygen was respired by methanotrophs. Kessler et al. (2011) suggest that the methane triggered a large methanotroph bloom that rapidly degraded the methane, leaving behind a residual methanotrophic community.

Early life stages of animals are usually more sensitive to environmental stress than adults (Moore and Dwyer, 1974). Oil can be lethal to fish, especially in larval and egg stages, depending on the time of the year that the event happened. Weathered crude oil has been shown in laboratory experiments to cause malformation, genetic damage, and even mortality at low levels in fish embryos of Pacific herring (Carls et al., 1998). Hernandez et al. (2010) recently studied seasonality in ichthyoplankton abundance and assemblage composition in the northern GOM off of Alabama. They found larvae representing 58 different families. Fish egg abundance, total larval abundance, and taxonomic diversity were significantly related to water temperature, not salinity, with peaks in spring, spring-summer, and summer. Detailed analyses of ichthyoplankton are not available east and west (closer to the spill) of the sampling station. The patterns found in this study do indicate, however, that a possible mortality occurred in the larval fishes of the Gulf that came in contact with the spilled oil. This depends on the timing of the spawn and the area influenced by the spill.

Specific effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes (internal lesions), effects of direct coating by oil (suffocation by coating gills), incorporation of hydrocarbons in organisms causing tainting or accumulation in the food chain, and changes in biological habitat (Moore and Dwyer, 1974).

The toxicity of an oil spill depends on the concentration of the hydrocarbon components exposed to the organisms (in this case fish) and the variation of the sensitivity of the species considered. The effects on and the extent of damage to fisheries resources from a petroleum spill are restricted by time and location. Oil has the potential to affect finfish through direct ingestion of hydrocarbons or ingestion of contaminated prey. Hydrocarbon uptake of prey can be by dissolved petroleum products through the gills and epithelium of adults and juveniles, decreased survival of larvae, and through the death of eggs (NRC, 1985 and 2002a). It can also result in incorporations of hydrocarbons in organisms causing tainting or accumulation in the food chain and changes in the biological habitat (Moore and Dwyer, 1974).

The effect of oil on fishes is also related to the distance from the shore, penetration into the estuaries the location in the Gulf of Mexico, and the time of the year that the spill occurs because the time of year determines the concentration of ichthyoplankton in the water. The level of impacts of oil on fish also depends on the amount of oil released, the toxicity of the oil, and the availability of bacteria to degrade the oil. The speed of degradation of the oil by bacteria is also related to the water temperature. Physical toxicity of oil to fishes depends on the application of dispersants and the toxicity of the dispersant. In the case of the DWH event, the application of the dispersant (COREXIT 9500) at the seafloor and the surface was alleged to have had the potential to produce larger areas of subsurface anoxic water because of the degradation of oil by bacteria. Fish resources are also affected by spills when their EFH is significantly and adversely affected. These effects can range from decreased water quality to decreased biomass of substrate such as large coral and vegetation communities. In the case of the DWH event, however, few offshore and onshore fish kills have been observed in Louisiana (Bourgeois, written communication, 2010a), Mississippi (Devers, official communication, 2010), and Alabama (Denson, official communication, 2010) (**Table 4-66**).

Accidental spills have the potential to affect sensitive species in the Gulf of Mexico, such as the Atlantic bluefin tuna that spawn in the Gulf of Mexico in April-May (Block et al., 2001). The Western Atlantic stock has suffered a significant decline in spawning stock biomass since 1950, and a 20-year rebuilding plan has failed to revive the population or the North American fishery. The failure of the Gulf of Mexico spawning population to rebuild, as well as the scope of illegal and under-reported catches (particularly in the Mediterranean Sea) are of such major concern that the species was considered by the Convention for International Trade in Endangered Species for endangered species listing in March 2010, but the measure did not pass. This listing would have limited international trade of Atlantic bluefin to nonmember Convention for International Trade in Endangered Species nations.

More recently, as a result of a petition by the Center for Biological Diversity, NMFS also considered listing Atlantic bluefin tuna as endangered or threatened under the ESA. On May 27, 2011, after extensive review, NMFS announced that the Atlantic bluefin tuna did not warrant species protection under the Endangered Species Act. The NMFS has, however, committed to review this decision in early 2013 based on a Stock Assessment to be completed in 2012 and pending more information on the DWH event (*Federal Register*, 2011c). Because of their decline in stock from overfishing, the timing of their spawn in the Gulf, their buoyant eggs, and the timing of the DWH event, there is concern about further decline in the Gulf stock of Atlantic bluefin tuna.

The effect of petroleum spills on most fish resources as a result of a CPA proposed action is expected to cause a minimal decrease in fish resources or standing stocks of any population. At the expected level of impact, the resultant influence on fish populations within or in the general vicinity of a CPA proposed lease sale area would be negligible and indistinguishable from natural population variations (e.g., year-class shifts due to climate or water current changes).

Proposed Action Analysis

A CPA proposed action is estimated to result in the drilling of a total of 168-329 exploration wells and 215-417 development and productions wells (**Table 3-3**). Of these productions wells, 81-156 are estimated to be producing oil wells and 108-241 are estimated to be producing gas wells (**Table 3-3**). A blowout with hydrocarbon release has a low probability of occurring as a result of a CPA proposed action. A blowout with an oil release is possible given the occurrence of the DWH event. Since the DWH event, BOEM has implemented a number of regulation changes to reduce the possibility of another such event. These regulations are described in detail in **Chapter 1.3**. There is a 40-62 percent chance of one or more spills ≥1,000 bbl occurring with a CPA proposed action (**Table 3-22**). The most likely source or cause of an offshore spill is also discussed in **Chapters 3.2.1.5 and 3.2.1.6.** The most likely size of spill is the smallest size group (<1 bbl; **Table 3-12**). Spills that contact coastal bays and estuaries would have the greatest potential to affect fish resources. The probability of an oil spill contacting an EFH in the CPA from a CPA proposed action after 10 days is between <0.5 and 41 percent; for specific State details, see **Figure 3-24**. The probability of an oil spill contacting an EFH in the CPA from a CPA proposed action after 30 days is between <0.5 and 45 percent; for specific State details, see **Figure 3-24**. The highest probability of contact is in the area considered with OSRA for EFH in Louisiana west of the Mississippi River. This area is estimated to be 64,357 km^2 (24,848 mi^2) of open water, and the OSRA model calculated contact as surface water. That is, the high percent of probable contact was for a large area and only for the upper water column EFH not the seafloor. The biological resources of other hard/live bottoms (EFH) would generally remain unharmed as spilled substances would, at the most, reach the seafloor in minute concentrations. This is because of the great distances and time required for transportation from the deepwater areas of a CPA proposed action.

There is a small risk of spills occurring during shore-based support activities, and the majority would be small in size because they would generally be limited to vessel and shore-based storage tanks with limited capacity. Most of these incidents would occur at or near pipeline terminals or shore bases and are expected to affect a highly localized area with low-level impacts. As a result of spill response and cleanup efforts, most of the inland spills would be recovered and what is not recovered would affect a small area and dissipate rapidly due to the smaller size of these spills generally, volatilization, and quicker response times for cleanup activities. It is also assumed that a petroleum spill would occasionally contact and affect nearshore and coastal areas important to GOM fisheries. These species are mobile and, based on typical observed behavior, these species would actively avoid the spill area.

Summary and Conclusion

Accidental events that could impact fish resources and EFH include blowouts and oil or chemical spills. Because subsurface blowouts, although a highly unlikely occurrence, suspend large amounts of sediment, they have the potential to adversely affect fish resources in the immediate area of the blowout.

If oil spills due to a CPA proposed action were to occur in open waters of the OCS proximate to mobile adult finfish, the effects would likely be nonfatal and the extent of damage would be reduced because adult fish have the ability to move away from a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. Benthic EFH's would have decreased effects from oil spills because of the depths many occupy and because of the distance these low probability spills would occur from benthic habitats (due to stipulations, NTL's, etc.). Fish populations may be impacted by an oil spill but they would be primarily affected if the oil reaches the shelf and estuarine areas because these are the most productive areas. Many species reside in estuaries for at least part of their life cycle or are dependent on the nutrients exported from the estuaries to the shelf region, but the probability of a spill in these areas is low. Also, much of the coastal northern Gulf of Mexico is a moderate- to high-energy environment; therefore, sediment transport and tidal stratification should reduce the chances for oil persisting in these habitats if they are oiled. Early life stages of animals are usually more sensitive to environmental stress than adults (Moore and Dwyer, 1974). Oil can be lethal to fish, especially in larval and egg stages, depending on the time of the year that the event happened. The extent of the impacts of the oil would depend on the properties of the oil and the time of year of the event.

The effect of proposed-action-related oil spills on fish resources is expected to cause a minimal decrease in standing stocks of any population because most spill events would be small in scale and localized; therefore, they would affect generally only a small portion of fish populations. Historically, there have been no oil spills of any size in the Gulf of Mexico that have had a long-term impact on fishery populations. Although many potential effects of the DWH event on the CPA have been alleged, the actual effects are, at this time, largely speculative, and the total impacts are likely to be unknown for several years. Recent analysis of early stage survival of fish species inhabiting seagrass nursery habitat from Chandeleur Islands, Louisiana, to St. Joseph Bay, Florida, pre- and post-DWH show that immediate catastrophic losses of 2010 cohorts were largely avoided and no shifts in species composition occurred following the spill (Fodrie and Heck , 2011). The fish populations of the GOM have repeatedly proven to be resilient to large, annually occurring areas of anoxia, major hurricanes, and oil spills. A CPA proposed action is not expected to significantly affect fish populations or EFH's in the Gulf of Mexico.

The BOEM has determined that it cannot obtain this information, regardless of cost, within the timeframe contemplated by this NEPA analysis, and it may be years before the information is available. In the meantime, as described above, where this incomplete information is relevant to reasonably foreseeable impacts, it was determined if it was essential to a reasoned choice among alternatives and if not, scientifically credible information that is available was used in its stead and applied using accepted methodology.

Although there is incomplete or unavailable information on the impacts of DWH on fish resources and EFH, BOEM has determined that it is impossible to obtain this information, regardless of cost, within the timeframe contemplated by this NEPA analysis, and it may be years before the information is available. This information is being developed through the NRDA process, data are still incoming and have not been made publicly available, and it is expected to be years before the information is available. In addition, as described above, where this incomplete information is relevant to reasonably foreseeable impacts, what scientifically credible information is available was used in its stead and applied using accepted scientific methodologies. Nevertheless, BOEM believes that this information is not essential to a reasoned choice among alternatives. The likely size of an accidental event resulting from a CPA proposed action would be small and unlikely to impact coastal and estuarine habitats where juvenile and larval stages of fish resources are predominant, and adult fish tend to avoid adverse water conditions.

4.2.1.18.4. Cumulative Impacts

Background/Introduction

This cumulative analysis summary includes effects on fish resources and EFH's of the OCS Program (a CPA proposed action and past and future OCS lease sales), State oil and gas activity, coastal development, crude oil imports by tanker, commercial and recreational fishing, and natural phenomena. An example of impact-producing factors considered in this cumulative analysis include cumulative onshore impacts on EFH's, including wetland loss as a result of human population expansion, environmental degradation, relative sea-level rise, and natural factors (e.g., hurricane loss of wetlands) (**Chapter 4.2.1.4.4**). Marine environmental degradation factors affecting water quality such as hypoxia are discussed in **Chapters 4.2.1.2.1.4 and 4.2.1.2.2.4**. Physical disturbances of live bottoms and topographic features including non-OCS-related disturbances such as those related to commercial and recreational fishing; and OCS-related activities such as the removal of production structures, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling mud and produced waters are discussed in **Chapters 4.2.1.6.1.4, 4.2.1.6.2.4**, **and 4.2.1.7.4,** and are summarized here.

Healthy fishery stocks depend on EFH's, which are waters and substrate necessary to fish for spawning, breeding, feeding, and growing to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in **Appendix D**) for marine species, EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone. The effects of cumulative actions on offshore water quality, live bottoms, topographic features, *Sargassum*, chemosynthetic and nonchemosynthetic communities, and soft-bottom communities are analyzed in detail in **Chapters 4.2.1.2.2.4, 4.2.1.6.1.4, 4.2.1.6.2.4, 4.2.1.7.4, 4.2.1.8.4, 4.2.1.9.4, 4.2.1.10.4, and 4.2.1.11.4**, respectively. The direct and/or indirect effects from cumulative OCS-related and non-OCS-related activities on EFH's and fish resources are considered and are summarized in this section.

OCS-Related Activities

The construction of new facilities will be closely scrutinized, although secondary impacts on estuarine habitats will continue to be the greatest and should receive greater attention. The present number of major navigation canals appears to be adequate for the OCS Program and most other developments. Some of these canals may be deepened or widened, and marine traffic causes erosion of adjacent wetlands. These secondary impacts of canals to wetlands will continue. Also, well-site construction activities include board roads, ring levees, and impoundments. The incremental contribution of a CPA proposed action would be a small part of the cumulative impacts to wetlands, seagrass communities, and coastal water quality but, with new technologies and continual regulation and monitoring by COE, these activities will cause fewer effects.

Sediment would potentially be resuspended during the installation of pipelines. An estimate of 0-1 pipeline is to make landfall in the CPA. Most oil and gas operations are assumed to use existing onshore structures and pipelines, which would have a small effect on coastal EFH and fish resources. A total of 8,515-16,993 km (5,291-10,559 mi) of pipeline is projected to be installed in the CPA (in water depths of <60 m; 200 ft) during the 40-year analysis period (**Table 3-6)**. In many areas of the Gulf of Mexico, sediments are not static, as evidenced by the relatively recently discovered deep-sea furrows (Bryant et al., 2004). Live-bottom features in the CPA consist of the East and West Flower Garden Banks, Sonnier and Stetson Banks, and the Pinnacle Trend. The Topographic Features Stipulation and the Live Bottoms (Pinnacle Trend/Low Relief) Stipulations, enacted by this Agency and clarified in its NTL 2009-G39, would prevent most of the potential impacts on live-bottom communities (EFH) from any OCS Program activities. This would be done by focusing OCS activities at specified distances from the live-bottom features, thereby increasing the distance between these features and routine activities and potential accidental event. In the case of a spill, this distance would reduce the potential for contact with the features, as the released oil would be expected to rise to the surface and disperse in the water. The OCS Program activities impacting live-bottom communities include bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling mud and cuttings and produced waters), and any nearby blowouts. Also, the guidelines provided in NTL 2009-G40 would decrease the impacts on other deepwater benthic communities such as chemosynthetic, nonchemosynthetic, and soft bottoms. These guidelines refer to bottom-disturbing activities such as pipeline trenching. Because the contribution of resuspended sediment as a result of pipeline trenching compared with the natural movement of sediment on the seafloor is very small, the effect on fish resources from pipeline trenching is expected to be minimal.

The projected total number of production structure installations resulting from OCS activities in the CPA during the next 40 years and for all water depths is 1,180-1,640 (**Table 3-6**). Bottom disturbance from structure emplacement operations associated with a CPA proposed action would produce localized and temporary increases in suspended sediment loading. This would result in decreased water clarity and little reintroduction of pollutants. Structure emplacements can act as fish-attracting devices and can result in the aggregation of migratory and reef fish species. This is likely to occur to some degree with these structures in the CPA. Structure removals would result in artificial habitat loss. It is estimated that 1,046-1,485 structures would be removed as a result of the OCS Program in the CPA during the next 40 years (**Table 3-6**). The removal of structures by using explosives results in a loss of artificial habitat and causes fish kills. It is estimated that 707-1,006 structures would be removed using explosives as a result of the OCS Program in the in the CPA over the next 40 years (**Table 3-6**). It is expected that structure removals would have a major effect on fish resources near the removal sites. Fish proximate to the removal sites that do not leave the area would be killed, and these expected impacts to fish resources have been shown to be small overall and they would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000). The Topographic Features and the Live Bottom Stipulations and the guidelines provided in NTL 2009-G40 would prevent most of the potential impacts on live-bottom and deepwater communities (EFH) from any OCS Program activities.

Localized, minor degradation of coastal water quality is expected from a CPA proposed action within the immediate vicinity of the waterbodies proximate to the proposed service bases, commercial waste-disposal facilities, and gas processing plants as a result of routine effluent discharges and runoff (**Chapter 4.2.1.2.1.4**). Because the input of effluent, runoff, and nutrients from a CPA proposed action is very limited, the incremental contribution of a proposed action would be a very small part of the cumulative impacts to coastal water quality. A CPA proposed action would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes and sedimentation/sediment resuspension (**Chapter 4.2.1.2.2.4**). Offshore vessel traffic and OCS operations would contribute in a small way to regional degradation of offshore waters through different waste discharges and spills.

Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. This is because offshore discharges of drilling mud dilute to near background levels within 1,000 m (3,281 ft) of the discharge point. Biomagnification of pollutants such as mercury are often associated with drilling discharges, but the bioavailability and any association with trace concentrations of mercury in discharged drilling mud has not been demonstrated. Numerous studies have concluded that platforms do not contribute to higher mercury levels in marine organisms. Recent data suggest that mercury in sediment from drilling platforms is not in a bioavailable form (Trefry et al., 2003). Because the deposition of drilling mud is limited in space around the platform and because the mercury contained in the mud is not in bioavailable form, the discharge of drilling mud around platforms is expected to have no effect on fish at a population level or to considerably decrease water quality.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. These include petroleum hydrocarbons, trace metals, radionuclides, and brine. Limited petroleum concentrations and metal contamination of sediments and the upper water column would occur out to several hundred meters or feet downcurrent from the discharge point. Because produced waters are limited in space and are quickly diluted, the effects of produced waters on fish populations in the OCS environment are expected to be small. Fish populations inhabiting offshore live bottoms would similarly not be impacted by produced waters because they are released and disperse near the surface and because the deposition of drilling mud is limited. Offshore discharges and subsequent changes to marine water quality are also regulated by the U.S. Environmental Protection Agency’s NPDES permits.

Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of drilling muds and produced water would disperse, would dilute to very near background levels within 1,000 m (3,281 ft) of the discharge point, and would have a negligible effect on fish resources. The use of BOEM’s stipulations would buffer important offshore habitats, and USEPA’s standards would further reduce the possible effects of discharges.

Recovery from impacts caused by unregulated operational discharges or an accidental blowout would take place within several years. For any activities associated with a CPA proposed action, USEPA's Region 6 will regulate discharge requirements through their NPDES individual discharge permits. In the unlikely event of an offshore spill, the biological resources of hard/topographic features would remain unharmed as the spilled substances could, at the most, reach the seafloor in minute concentrations. These minute quantities may cause very short-term sublethal effects (changes in physiology) in benthic organisms that will recover quickly.

Surface oil spills would have the greatest chance of impacting high-relief topographic features located in depths <20 m (66 ft; mostly sublethal impacts). All major topographic features are well described in **Chapter 4.2.1.7.1** and the live-bottom Pinnacle Trend/low relief features are described in **Chapters 4.2.1.6.1.1 and 4.2.1.6.2.1**, respectively. Only three high-relief features in the Gulf rise to water depths shallower than 20 m (66 ft). These are the East Flower Garden Bank (16 m; 52 ft), Stetson Bank (17 m; 55 ft), and Sonnier Bank (17 m; 55 ft), all of which are in the WPA.

Subsurface spills (pipeline spills) could cause localized, sublethal (short-term, physiological changes) impacts on the live bottoms; however, such events would be highly unlikely since the protective lease stipulations would prevent oil lines from being installed in the immediate vicinity of high-relief live bottoms. The impact of OCS-related activities on the live bottoms of the cumulative activity area would probably be slight because community-wide impacts should not occur. Impacts on fish populations from these events are expected to be undetectable because they would be localized and temporary in nature.

Oil spills that contact coastal bays, estuaries, and offshore waters (each are EFH) when pelagic eggs and larvae are present have the greatest potential to affect fish resources. If spills were to occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For eggs and larvae contacted by spilled diesel, the effect is expected to be lethal.

Contamination from oil and hazardous substance spills should be primarily localized and not long term enough to preclude designated uses of the waters. All spill incidents (OCS and others) and activities increasing water-column turbidity are assumed to cause localized water quality changes for up to 3 months for each incident. It is expected that small coastal oil spills from non-OCS sources would often affect coastal bays and marshes (both are EFH) essential to the well being of the fish resources. It is estimated that up to one offshore spill ≥1,000 bbl could occur based on a CPA proposed action (**Table 3-12**). A large coastal spill that could occur from OCS-related activity in the CPA would likely originate near terminal locations in the coastal zone of the CPA. As a result of spill response and cleanup efforts, most of the inland spills would be recovered and what is not recovered would affect a small area and dissipate rapidly. The probability of an oil spill contacting an EFH in the CPA from a CPA proposed action after 10 days is <0.5-41 percent for the entire GOM; for specific State details, see **Figure 3-24**. Subsurface gas blowouts of both oil and natural gas wells have the potential to affect adversely fishery resources. The loss of well control and resultant blowouts seldom occur on the Gulf of Mexico OCS. Sandy sediments would be quickly redeposited within 400 m (1,312 ft) of a blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters over a period of 30 days or longer. These events are expected to have a negligible impact on fish populations. It is expected that the infrequent subsurface natural gas blowout that may occur on the Gulf of Mexico OCS would have a negligible effect on offshore fish resources.

Subsurface blowouts, such as the DWH event, that include both oil and natural gas have the potential to affect fish populations, particularly eggs, larvae, and juveniles. The specific effects of this type of spill on individual fish populations in the GOM are currently being investigated. Few, if any, definitive results have been obtained at this time. Spills from this type of a blowout have a low probability of occurring. The cumulative impact on EFH and fish populations is, therefore, not anticipated to be large as a result of a CPA proposed action.

Non-OCS-Related Activities

The conversion of wetlands for agricultural, residential, and commercial uses has been substantial. The trend is projected to continue into the future, although at a slower rate because of regulatory pressures. The most serious impact to EFH is the cumulative effects on wetlands that are occurring at an ever-increasing rate as the Gulf Coast States' human populations increase and with relative sea-level rise

(GMFMC, 1998). Residential, commercial, and industrial developments are directly impacting EFH by dredging and filling coastal areas or by affecting the watersheds. Also, this conversion of wetland habitat into open water is projected to continue in the foreseeable future. This is actually a shift in EFH from important nursery habitat to open-water habitat. Within the northern Gulf coastal areas, river channelization and flood protection have greatly restricted the most effective wetland creation activities. Flood control has fostered development, which has impacted wetlands and reduced their area. State oil production and related activities are projected to have greater and more frequent adverse impacts on wetlands than would the OCS Program offshore activities because of their proximity to the shore. Other factors that impact coastal wetlands include marsh burning and marsh-buggy traffic. Tracks left by marsh buggies open new routes of water flow through relatively unbroken marsh and can persist for up to 30 years, thereby inducing and accelerating erosion and sediment export.

Canal dredging primarily accommodates commercial, residential, and recreational development. Increased population and commercial pressures on the coast of the CPA are also causing the expansion of ports and marinas there. Where new channels are dredged, wetlands would be adversely impacted by the channel, disposal of dredged materials, and the development that it attracts. The continuing erosion of waterways maintained by COE is projected to adversely impact the productivity of wetlands along channel banks. Also, increased turbidity from dredging operations projected to continue within the coastal zone constitutes another considerable type of pollution. However, continual advances in technologies and mitigation required by COE in permits decrease many adverse effects on coastal habitats and water quality from dredging and related activities.

The coastal waters of portions in the CPA are expected to continue to experience nutrient enrichment, low-dissolved oxygen, and toxin and pesticide contamination, resulting in the loss of both commercial and recreational uses of the affected waters. Fish kills, shellfish-ground closures, and restricted swimming areas will likely increase in numbers over the next 30-40 years based on impacts from the non-OCS-related impacts described above. Degradation of water quality is expected to continue due to contamination by point- and nonpoint-source discharges due to eutrophication of waterbodies, primarily due to runoff and hydrologic modifications. Contamination of the coastal waters by natural and manmade noxious compounds coming from point and nonpoint sources and accidental spills derived from both rural and urban sources will be both localized and pervasive. Runoff and wastewater discharge from these sources will cause water quality changes that will result in a significant percentage of coastal waters not attaining Federal water quality standards. However, stringent water quality standards are monitored and enforced by USEPA and USCG. Municipal, agricultural, and industrial coastal discharges and land runoff would impact the health of marine waters. As the assimilative capacity of coastal waters is exceeded, there will be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of the designated uses of some shallow offshore waters due to hypoxia and red or brown tide impacts and to levels of contaminants in some fish exceeding human health standards. Coastal sources are assumed to exceed all other sources, with the Mississippi River continuing to be the major source of contaminants to the north-central Gulf area.

Commercial fishing activities that could impact topographic features would include trawl fishing and trap fishing. With the exception of localized harvesting techniques, most wild-caught shrimp are collected using bottom trawls – nets towed along the seafloor – held apart with heavy bottom sled devices called “doors” made of wood or steel. In addition to the nonselective nature of bottom trawls, they can be potentially damaging to the bottom community as they drag. Trawls pulled over the bottom disrupt the communities that live on and just below the surface and also increases turbidity of the water (GMFMC, 1998).

Throughout the Gulf Coast, commercial trap fishing is used for the capture of reef fish, and commercial and recreational trap fishing is used for the capture of spiny lobster, stone crab, and blue crab. Reef fish traps are primarily constructed of vinyl-covered wire mesh and include a tapered funnel where the fish can enter but not escape. Traps can potentially damage the bottom community, depending on where they are placed. If they are deployed and retrieved from coral habitats or live bottoms, they can damage the corals and other attached invertebrates on the reef. Seagrasses can also be broken or destroyed by the placement and retrieval of traps in shallow environments (GMFMC, 1998).

Overfishing (commercial and recreational) has been determined to be a major factor in four populations of reef fish in the Gulf of Mexico. For 2009, overfished species include the gag grouper, greater amberjack, red snapper, and gray triggerfish. These species are reef fish that range throughout the Gulf and are discussed in **Chapters 4.2.1.19.1 and 4.2.1.20.1 and Appendix D**. In the case of the red snapper, bycatch from the shrimp industry in the small (0-1) year classes of red snapper is a major factor in this species' decline. Many of the important species harvested from the Gulf of Mexico are believed to have been overfished, while overfishing is still taking place (USDOC, NMFS, 2010c). Continued fishing at the present levels may result in declines of fish resource populations and the eventual failure of certain fisheries. It is expected that overfishing of targeted species and trawl fishery bycatch will adversely affect fish resources. The impact of overfishing on fish resources is expected to cause a measurable decrease in populations, although the GMFMC has taken action to avoid the exploitation of overfished species in the form of increased regulations. At the estimated level of effect, the resultant influence on fish resources is expected to be substantial and easily distinguished from effects due to natural population variations from factors such as climate or water circulation.

Invasive species such as lionfish have been identified across the Gulf of Mexico. Lionfish are native to the Indo-Pacific region, but they have observed on reefs as far as the central Gulf of Mexico. Lionfish are voracious predators, competing with natural reef inhabitants for food sources and habitat space.

Finally, hurricanes may impact fish resources by destroying offshore live-bottom and reef communities and changing physical characteristics of inshore and offshore ecosystems. The incremental contribution of impacts on fish and EFH from a CPA proposed action to the cumulative impacts on offshore communities would be small (as analyzed in **Chapters 4.2.1.6.1.4, 4.2.1.6.2.4**, **4.2.1.7.4, 4.2.1.8.4**, **4.2.1.9.4**, **4.2.1.10.4**, **and 4.2.1.11.4**).

Summary and Conclusion

In summary, along with a CPA proposed action there are widespread anthropogenic and natural factors that impact EFH and fish populations in the Gulf of Mexico. Different OCS-related construction can range from onshore facilities to well-site construction activities including board roads, ring levees, and impoundments. With the number of pipelines estimated for a CPA proposed action, sediment would potentially be resuspended in localized areas. The explosive removal of structures does have a negative effect on those fish in close proximity. The OCS activities such as the emplacement of structures and of artificial reefs also have a positive effect by providing habitat and/or food for reef fishes, but their removals can be detrimental. Discharges from OCS activities such as drill mud and produced water have an incremental effect on offshore water quality. All discharges are regulated by USEPA or State agencies. Oil spills, although considered rare events, can affect offshore waters. Fish are known to actively avoid areas of oil spills as they avoid any area of adverse water quality, such as hypoxic waters (Wannamaker and Rice, 2000). The OCS-related activities that could physically destroy live bottoms (e.g., anchoring and using anchor chains) are mitigated by BOEM. The OCS factors potentially impacting fish resources in the Gulf of Mexico are federally regulated or mitigated and are small. There are many anthropogenic factors that are regulated by Federal and State agencies, and there are natural factors that cannot be regulated. Also to be considered is the variability in GOM fish populations due to natural factors such as spawning success and juvenile survival. Overall, the incremental contribution of the OCS effects to fish populations is small.

Wetland loss as a result commercial and residential development is one of the major factors in this trend although this is regulated and mitigated by COE. Inshore inputs of pollutants to estuaries from runoff and industry are also contributors to wetland loss. Canal dredging primarily accommodates commercial, residential, and recreational development. Increased population and commercial pressures on the CPA coast are also causing the expansion of ports and marinas there. The coastal waters of the CPA are expected to continue to experience nutrient enrichment, low-dissolved oxygen, and toxin and pesticide contamination, resulting in the loss of both commercial and recreational uses of the affected waters. The degradation of water quality is expected to continue due to contamination by point- and nonpoint-source discharges due to eutrophication of waterbodies, primarily due to runoff and hydrologic modifications. Resource management agencies, both State and Federal, set restrictions and permits in an effort to mitigate both the effects of development projects and industry activities. The Federal and State governments are also funding research and coastal restoration projects; however, it may take decades of monitoring to ascertain the long-term feasibility of these coastal restoration efforts.

Overfishing (including bycatch) has impacted some populations of GOM fish. The Magnuson-Stevens Fishery Conservation and Management Act and its amendments address sustainable fisheries and set guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities.

Limits on catch and fishing seasons are set by the GMFMC. State agencies regulate inshore fishing seasons and limits.

Naturally occurring tropical cyclones can cause damage to various EFH's. These can be onshore as with wetland loss and offshore with damaged topographic features. These storms are a continual part of the Gulf of Mexico climate.

All of these events and activities cause some sort of effect on the different EFH's and fish resources. Many anthropogenic inputs, including a CPA proposed action, are now monitored, regulated, and mitigated by the permitting agency or State. These efforts will continue in the future, and restoration of habitats could increase with better technologies. While EFH and fish resources are impacted by these many factors, a CPA proposed action would add a minimal amount to the overall cumulative effects.

As noted above in the affected environment section, most of the Gulf of Mexico is designated as EFH and encompasses many different types of habitats and resources described in this EIS. The extent of impacts from the DWH event to EFH and fish resources remains unclear at this time. This information is being developed through the NRDA process, data are still incoming and have not been made publicly available, and it is expected to be years before the information is available. In addition, as described above, where this incomplete information is relevant to reasonably foreseeable impacts, what scientifically credible information is available was used in its stead and applied using accepted scientific methodologies. Although incomplete or unavailable information may be relevant to reasonably foreseeable adverse impacts, this incomplete or unavailable information is not essential to a reasoned choice among alternatives. Compared with other impacting factors on EFH and fish resources, including those related to coastal and marine degradation, wetland loss, vessel traffic, and coastal development, a CPA proposed action is not likely to result in an incremental increase in impacts to EFH and fish resources, regardless of any lingering impacts from DWH.

4.2.1.19. Commercial Fishing

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this section. A summary of those analyses and their reexamination due to new information is presented in the following sections. A brief summary of potential impacts follows. Routine activities in the CPA, such as seismic surveys and pipeline trenching, would cause negligible impacts and would not deleteriously affect commercial fishing activities. Indirect impacts from routine activities to inshore habitats are negligible and indistinguishable from direct impacts of non-OCS energy-related, inshore activities on commercial fisheries. The potential impacts from accidental events (i.e., a well blowout or an oil spill) associated with a CPA proposed action are anticipated to be minimal. Commercial fishermen are anticipated to avoid the area of a well blowout or an oil spill. Any impact on catch or value of catch would be insignificant compared with natural variability and other pressures affecting the resource. The incremental contribution of a CPA proposed action to the cumulative impacts on commercial fishing is small, and it is expected to be negligible and indiscernible from natural fishery population variability.

4.2.1.19.1. Description of the Affected Environment

Commercial fishing regulations are detailed and change on a regular basis depending on a variety of factors, including stock assessment and catch statistics. These regular changes, not withstanding any closures based on the DWH event, can occur on short notice. This is especially true for time closures based on allowable catches. The Gulf of Mexico Fishery Management Council provides the current information on commercial and recreational fishing rules for U.S. Federal waters of the Gulf of Mexico (GMFMC, 2010a and 2010b).

Menhaden, with landings of over 1 billion pounds and valued at $60.5 million, was the most important Gulf species in terms of quantity landed during 2009. The menhaden catch was up from 927.5 million pounds worth $64.3 million in 2008 in the Gulf of Mexico, although the price per pound was down (USDOC, NMFS, 2011e). In 2010, the Gulf menhaden harvest was approximately 0.97 million pounds valued at $66 million. The catch was down approximately 30 percent from 2009, but it was up approximately 4 percent from the 2008 harvest (USDOC, NMFS, 2011e). Menhaden are harvested extensively for their oil, which is included in animal food and human supplements as Omega-3 fatty acid. This species is harvested primarily in Louisiana and Mississippi.

All commercial fisheries data referenced in this section were obtained from NMFS (USDOC, NMFS, 2011e). Commercial shellfish of most importance to the central Gulf Coast include shrimp (primarily brown and white), blue crabs, and oysters. In 2009, the central and eastern Gulf Coast States harvested a total of nearly 50.5 million pounds of brown shrimp and over 76.6 million pounds of white shrimp. This constitutes approximately 41 percent and 69 percent of the brown (*Farfantepenaeus aztecus*) and white shrimp, (*Litopenaeus setiferus)*, respectively, harvested in the entire U.S. that year. The 2010 harvest of white shrimp from the central and eastern Gulf Coast States was down to 24.9 million pounds (24% of the U.S. harvest), probably as a result of fisheries closures during brown shrimp seasons in the central Gulf Coast.

Blue crab (*Callinectes sapidus*) harvest in the three central Gulf Coast States was approximately 56.1 million pounds in 2009 and 37.7 million pounds in 2010, or about 35 percent of the total U.S. harvest in 2009 and 20 percent of the total U.S. harvest in 2010. Eastern oyster (*Crassostera virginica*) harvest in Louisiana, Mississippi, and Alabama and the West Coast of Florida in 2009 totaled 19.9 million pounds of oyster meat. Louisiana alone harvested 14.7 million pounds of oyster meats, or 59.5 percent of all of the Eastern oyster meats harvested in the U.S. in 2009. Oyster harvest in 2010 from the four Gulf Coast States totaled 15.6 million pounds. Louisiana harvest was down to 6.7 million pounds.

Total fisheries landings in Louisiana in 2009 were just over 1 billion pounds, up approximately 9.4 percent from 2008 landings of 919 million pounds. The 2010 total fisheries landings were approximately 1 billion pounds, very near the 2009 level. The value of the 2009 harvest at almost $284.5 million was up 3.3 percent from the 2008 value of $275.2 million. Louisiana landings in 2008, 2009, and 2010 were dominated by menhaden. Shellfish catch was dominated by white shrimp, blue crab, and brown shrimp in all three years.

Total fisheries landings in Mississippi in 2009 were approximately 230 million pounds, an increase of approximately 12 percent over the 202 million pounds landed in 2008. The value of the landings, however, decreased from $43.7 million in 2008 to approximately $38 million in 2009, a decrease of 15 percent. Total Mississippi catch in 2010 decreased to 111 million pounds, a 52 percent decrease over the 2009 catch. The value of the 2010 catch was $21.9 million, down about 42 percent from 2009. Total fisheries landings in Mississippi in 2008, 2009, and 2010 were dominated by the menhaden fishery. Shellfish harvest was dominated by brown shrimp, white shrimp, and oysters in all three years.

The 2009 total catch in Alabama was 28.8 million pounds, an increase of nearly 15 percent over the 2008 catch of 24.4 million pounds. Catch value, however, decreased from $44 million in 2008 to $40 million in 2009. Finfish catch in Alabama has been dominated by striped mullet in recent years. Striped mullet landings in 2008 were over 1.8 million pounds at a value of $0.9 million, while menhaden landings were only 268,000 pounds valued at $59 thousand. A similar pattern was observed in 2009, with landings of striped mullet of approximately 1.8 million pounds valued at $0.8 million and menhaden catch of 189,000 pounds valued at $40 thousand. Similarly, in 2010 the strip mullet catch was 1.1 million pounds, valued at $0.6 million, and menhaden catch was 81,000 pounds with a value of $14 thousand. Shellfish harvested in Alabama, in decreasing order of pounds harvested and value in 2008, 2009, and 2010, were brown shrimp, white shrimp, and blue crabs.

Total fisheries harvested from the West Coast of Florida in 2009 amounted to over 65 million pounds valued at slightly approximately $115 million, an 8 percent increase over 2008 fisheries of just over 60 million pounds valued at $123 million. Striped mullet constituted the largest catch in pounds, with 6.9 million pounds in 2008, 8.03 pounds million in 2009, and 8.2 million pounds in 2010; however, red grouper was the most valuable finfish catch at $13.6 million in 2008, $10.5 million in 2009, and $8.9 million in 2010. Shellfish harvested from the West Coast of Florida in 2008, 2009, and 2010 included Caribbean spiny lobster, blue crabs, pink shrimp, and the Eastern oyster.

On August 4, 2000, NMFS announced some new regulations to reduce bycatch and bycatch mortality in the pelagic longline fishery. On November 1, 2000, NMFS put into effect a new regulation to reduce bycatch and bycatch mortality in the pelagic longline fishery. Two rectangular areas in the Gulf of Mexico (one of which lies over a portion of the region known as De Soto Canyon) are closed year-round to pelagic longline fishing. These closed areas cover 32,800 mi^2 (84,852 km^2) (**Figure 4-44**). This region has been identified by NMFS as a swordfish nursery area, where there has historically been a low ratio of swordfish kept to the number of undersized swordfish discarded, which over the period of 1993-1998 has averaged less than one swordfish kept to one swordfish discarded. The area closure is expected to produce approximately a 4-percent reduction in Gulf and Atlantic undersized swordfish bycatch.

Upper Area	
North boundary:	30^o N. latitude
South boundary:	28^o N. latitude
East boundary:	86^o W. longitude
West boundary:	88^o W. longitude
Lower Area	
North boundary:	28^o N. latitude
South boundary:	26^o N. latitude
East boundary:	84^o W. longitude
West boundary:	86^o W. longitude

Total Gulf fisheries harvest in million pounds and value in million dollars is shown in **Figure 4-45** Fisheries harvest estimates are complex and vary with regulations and restrictions of fishing season. These restrictions can be related to managed species, natural factors affecting populations (i.e., storms, hurricanes, and high and low water years in major river basins) and economic factors (i.e., price of fuel), and the availability of infrastructure such as wholesale docks. The fishery can also be affected by the import of foreign product, i.e., shrimp and farm raised-finfish. During the period 2000-2009 all of these factors were important, affecting one or another species or area.

In 2005, Hurricanes Katrina and Rita affected Alabama, Louisiana, and Mississippi. Hurricane Katrina destroyed infrastructure and boats and also caused major landloss along the Gulf Coast. In September 2008, Hurricanes Gustav and Ike made landfall on the Gulf Coast. Hurricane Gustav came ashore southwest of New Orleans as a Category 2 storm. Hurricane Ike made landfall as a Category 2 storm at Galveston, Texas. In April 2009, the Louisiana Dept. of Wildlife and Fisheries announced a $15.7 million cooperative research program with NMFS to monitor the recovery of Louisiana commercial fisheries impacted by Hurricanes Katrina, Rita, Gustav, and Ike (Louisiana Dept. of Wildlife and Fisheries, 2009). Caffey (official communication, 2009) estimated revenue losses from Hurricanes Gustav and Ike on Louisiana fisheries and aquaculture sectors in excess of $98 million. The NMFS landings data show a drop in finfish and shrimp harvest in Louisiana (USDOC, NMFS, 2011e). This may be due to loss of boats and infrastructure.

In September 2008, the Louisiana Dept. of Wildlife and Fisheries (2008a and 2008b) released preliminary, nonquantitative reports of the effects of Hurricane Gustav on Louisiana fisheries. In the reports, they noted the extensive marsh erosion and vegetative debris present in the canals of southeastern Louisiana. There was a loss of marsh through erosion and displacement and encroachment of saltwater into freshwater areas, which contributes to the loss of essential fish habitat, and localized fish kills.

The DWH event changed the baseline of GOM commercial fishing, at least for the 2010 fishing season, because of the massive fishing closures associated with the event. This spill resulted in commercial fisheries closures in the GOM waters (Exclusive Economic Zone) as well as State and inshore waters in Louisiana, Mississippi, Alabama, and Florida at various times during the spill. State commercial fishing areas changed with the movement of the oil. The closures were generally limited to the area between Vermilion Bay, Louisiana, and Pensacola, Florida.

The fishing closure area in the Gulf varied from 6,817 mi^2 (17,648 km^2) on May 2, 2010, when the closure was initiated, to a high of 88,522 mi^2 (229,270 km^2) or 36 percent of the Exclusive Economic Zone on June 2, 2010. The closure area was located off the coasts of Louisiana, Mississippi, Alabama, and Florida based on projections of the path of the spilled oil. The closed area increased as the spill continued and spread (USDOC, NOAA, 2011h). On April 19, 2011, NMFS reopened to commercial and recreational fishing the last areas of the Gulf closed to fishing due to the DWH spill (USDOC, NMFS, 2011h).

As a result of the DWH event and the closures related to it, NMFS (USDOC, NMFS, 2011g) statistics released for 2010 show decreases in most, although no all, commercially important species. A total of 1.283 billion pounds of finfish and shellfish combined were landed from Gulf Coast States in 2010, an 18.5 percent drop in harvest from 2009 (1.574 billion pounds), but this was a 0.6 percent increase over 2008 total landings (1.278 billion pounds). All of the Gulf Coast States showed decreased 2010 total landings compared with 2009 total landings. The losses were not even in all states nor were they even in all species fished. Some species showed decreased landings, and some showed increased landings over previous years (USDOC, NMFS, 2011g).

The Gulf menhaden harvest, the largest cash crop in the Gulf of Mexico, which was limited to the States of Louisiana, Mississippi, Alabama, and the West Coast of Florida and was most predominant in Louisiana and Mississippi, was .97 billion pounds, down approximately 30 percent from the 2009 harvest of 1.3 billion pounds, but it was up approximately 4 percent from the 2008 harvest of 0.93 billion pounds. Bluefin tuna harvest in Gulf waters, limited to the West Coast of Florida and Louisiana, increased from 17.4 million tons in 2009 to 20.5 million tons in 2010.

The resulting impacts for the short- and long-term of the DWH event to commercial finfish species of the Gulf Coast are unknown at this time. Because nondispersed oil generally floats on the surface of water, the fisheries resources most at risk are those species whose eggs and larvae float near the water surface. Some species have spawning periods with narrow temporal peaks coinciding with the timing of the highest oil concentrations. These species could experience measurable effects on that area's year class. Early developmental stages are generally more susceptible to sublethal toxic effects, which may lead to abnormal development.

One important highly migratory species with a spawning period coinciding with the spill is the Atlantic bluefin tuna. This species has its peak spawning period in April and May in the Gulf (Teo et al., 2007a and 2007b). A catastrophic spill, such as the DWH event, during the spring season may cause a negative effect on this population. This is one of only two documented spawning grounds for the Atlantic bluefin tuna (the other is in the Mediterranean). Eggs are buoyant, which puts them at greater risk of floating oil. Bluefin tuna are among the most valuable fish in global markets.

The Western Atlantic stock has suffered a significant decline in spawning stock biomass since 1950, and a 20-year rebuilding plan has failed to revive the population or the North American fishery. The failure of the Gulf of Mexico spawning population to rebuild and the scope of illegal and under-reported catches, particularly in the Mediterranean Sea, are of such major concern that the species was recently considered by the Convention for International Trade in Endangered Species for endangered species listing in March 2010. More recently, as a result of a petition by the Center for Biological Diversity, NMFS also considered listing Atlantic bluefin tuna as endangered or threatened under the Endangered Species Act. On May 27, 2011, after extensive review, NMFS announced that the bluefin tuna did not warrant species protection under the Endangered Species Act. The NMFS has, however, committed to review this decision in early 2013 based on a Stock Assessment to be completed in 2012 and pending more information on the DWH event (*Federal Register*, 2011c).

Because of their decline in stock, the timing of their spawn in the Gulf, their buoyant eggs, and the timing of the DWH event, there is concern about further decline in the Gulf stock of bluefin tuna. The effects at this time are, however, unknown.

There may be many other commercially important species such as menhaden, red snapper, groupers, mackerel, swordfish, sheepshead, blacktip sharks, red drum, speckled trout, and many more that occur on the shelf or in estuarine waters that have been affected in the long term by the DWH event. Due to the lack of published/analyzed data, these effects are uncertain at this time. The largest fishery in the Gulf Coast is menhaden. Menhaden are small schooling fish that are surface feeders, making them very vulnerable to the surface oil. One recently published study (Fodrie and Heck, 2011) did, however, conclude that catastrophic losses of 2010 cohorts for a number of species were avoided and that there were no discernible shifts in fish species composition following the spill.

There have been some confirmed reports of inshore fish kills, particularly in Louisiana, Mississippi, and Alabama. Fish kills have been reported in inshore Louisiana behind the Chandeleur Islands, behind the rock jetties at the mouth of the Mississippi River Gulf Outlet, at Joshua's Marina south of Empire, in Bayou Chaland, and in Bay Joe Wise. Communications with Martin Bourgeois (official communication, 2010a) and Harry Blanchet (official communication, 2010) about these various kills between August 24 and September 24, 2010, confirm that most of the species that died were menhaden in high-temperature, low dissolved oxygen waters. This is not unusual during the summer in the shallow, high-temperature, low dissolved oxygen waters of Louisiana that contain large concentrations of fish. It is impossible, however, to discount completely that the oil spill contributed to the oxygen depletion of these waters. While oxygen depletion is a somewhat common occurrence in the Gulf, oil cannot be ruled out as a factor contributing to low dissolved oxygen. Fish kills in Louisiana and Mississippi are summarized in **Table 4-66**. Personnel from the Alabama Dept. of Environmental Monitoring confirmed that there had been some fish kills in Mobile Bay, all of which had been attributed to low dissolved oxygen and high temperatures (Denson, personal communication, 2010).

Information from the Louisiana Dept. of Wildlife and Fisheries on fish kills in the summer of 2011 (Adriance, official communication, 2011) lists eight fish kills in 2011, beginning on May 11. All of the kills involved menhaden, with the exception of a single fish kill on Elmer's Island involving 500,000+ fish, mostly 5- to 6-in (13- to 15-cm) croaker; the cause is listed as unknown. The other kills involved between 1,000 and 100,000 menhaden, and the causes were listed as unknown or low dissolved oxygen.

Two large fish kills and one small fish kill have been reported in Mississippi by the Mississippi Dept. of Marine Resources. The first high biomass fish kill was on June 1, 2011, in Auguste Bayou, Biloxi, Mississippi. The number of dead fish estimated was approximately 55,900 with 99 percent of the dead fish being juvenile menhaden (1-2 in; 2.5-5 cm). The kill was attributed to a depletion of dissolved oxygen in the water due to high temperatures and high biomass in a small area (Devers, official communication, 2010). The other high biomass fish kill occurred on July 26, 2011, in Gautier, Mississippi, off of both Mackerel and Flounder Drives. The total gross estimate of the number of dead fish was nearly 1.5 million. The only observed species was the Gulf menhaden, all approximately 5 cm (2 in) in length (Devers, official communication, 2010).

Recent analysis of early stage survival of fish species inhabiting seagrass nursery habitat from Chandeleur Islands, Louisiana, to St. Joseph Bay, Florida, pre- and post-DWH show that immediate catastrophic losses of 2010 cohorts were largely avoided and no shifts in species composition occurred following the DWH spill (Fodrie and Heck, 2011). Fodrie and Heck do caution that long-term impacts and delayed, indirect effects of the oil on these populations must now be considered.

The commercially important species of shrimp (particularly the white and brown shrimp of Louisiana and Mississippi) and blue crabs spend at least part of their life cycle in the estuaries or on the nearshore shelf. Both shrimp species and the blue crab spawn in high salinity waters offshore, and the larvae and subadults move inshore to mature in the estuaries of the coast. These species are short lived, and losses to the crop from the DWH event may be evident in the 2011 harvest if they are not offset by the fishing closures.

White shrimp harvest in 2010 decreased approximately 11 percent in the Gulf of Mexico from 101.7 million pounds in 2009 to 90.7 million pounds in 2010. The two states showing an increase in the 2010 harvest over the 2009 harvest were Texas and the West Coast of Florida (USDOC, NMFS, 2011g). The 2010 brown shrimp harvest of 73.3 million pounds was down approximately 37.6 percent from the 2009 season of 117 million pounds and 7 percent from the 2008 season landings of 79.0 million pounds. Brown shrimp landings were down in all Gulf Coast States (USDOC, NMFS, 2011g). The blue crab harvest in the Gulf Coast States decreased from 58.9 million pounds in 2009 to 41.0 million pounds in 2010 (30.4%). This represented a decreased harvest in Louisiana, Mississippi, and Alabama, and an increased harvest in Texas and the West Coast of Florida (USDOC, NMFS, 2011g).

Eastern oyster grounds are located in the CPA from Sabine and Calcasieu Lakes eastward in the inshore bays and estuaries of Louisiana, through eastern Mississippi Sound (Mississippi), Mobile Bay (Alabama), and from upper Pensacola Bay through Apalachicola Bay (Florida). Public seed grounds in Louisiana include Calcasieu and Sabine Lakes, Bay Gardene, Hackberry Bay, Sister Lake, Bay Junop, Lake Borgne, Breton/Chandeleur Sound, Barataria Bay, Little Lake, Deep Lake, Lake Chien, Lake Felicity, Lake Tambour, Lake Mechant, and Vermilion/Cote Blanche and Atchafalaya Bays (Louisiana Dept. of Wildlife and Fisheries, 2010). These seed grounds provide a source of spat (small oysters) for oystermen to transplant to their leases for grow-out, as well as a source of sack-sized oysters that can be readily marketed. Every July, the Louisiana Dept. of Wildlife and Fisheries conducts a survey of thee public seed grounds. The general trend of oyster abundance on the seed grounds has been decreasing since 2001, approaching the 2nd smallest statewide stock size since 1989. According to the 2010 assessment, the 2010 stock size showed an overall slight increase over the 2009 stock size (Louisiana Dept. of Wildlife and Fisheries, 2010).

The DWH event may have an effect on this year's crop, but it is difficult to infer with the current lack of public data. Many of the beds have been closed for most of the season. The public seed ground openings for much of the area east of the Mississippi River and Hackberry Bay west of the Mississippi River that were scheduled for November 15, 2010, have been postponed indefinitely because of the small size of the stock present in that area. Although the small stock size has not been directly attributed to the spill, it may be a result of the freshwater diversions that were operated in an attempt to keep oil from reaching the inshore areas.

The larval and juvenile stages of aquatic organisms are more vulnerable to contact with hydrocarbons than adults (Moore and Dwyer, 1974). Contact with oil does not always kill adult oysters, a fact demonstrated by Mackin and Sparks (1961), but it does affect their taste and render them unmarketable. Oysters will clear themselves of the taste given clean water conditions. If, however, the oil is combined with other stress factors, such as extreme temperatures and low salinities, death may result. In an attempt to keep the oil out of the inshore areas of Louisiana, the freshwater diversions were run at near maximum capacity. Sustained freshwater kills oysters, especially at high temperatures (Davis, 1958). The higher the temperature and the lower the salinity, the shorter the oyster life will be.

Representatives of the Louisiana Dept. of Wildlife and Fisheries confirmed that there had been a complaint of an oyster kill in Bay Jacques in Plaquemines Parish, Louisiana, on June 20, 2010 (Bourgeois, official communication, 2010b). The report reads as follows:

> They saw approximately 100 floating pieces of oysters (more were seen coming from the prop wash so likely more dead ones on the bottom), but it is nearly impossible to estimate. Coordinates in decimal degrees—N29.28725 W89.51665, coordinates in decimal minutes—N29°17.235' W89°30.999'. There are fish swimming in the area and no dead fish were seen. The surface DO was 10.2 mg/L, pH was 8.7, temp was 32.9°C, and salinity was 0.9 ppt. Bottom DO was 10.1 mg/L, pH was 8.7, temp was 32.9°C, and salinity was 0.9 ppt. Low salinity and high temperature combined appear to be responsible for this kill although other factors cannot be excluded.

Mississippi Sound and Alabama oyster beds were closed to oyster fishing for approximately 2 months during the summer of 2010. There are several areas of oyster reefs in the panhandle of Florida; Pensacola, Choctawhatchee, St. Andrew, and Apalachicola. The primary producing area is Apalachicola Bay. None of the Florida Panhandle reefs areas were closed as a result of the spill.

Banks (2011) released a report on oyster mortality in the Breton Sound and Barataria Basins that resulted from low salinities and high temperatures experienced in both basins during the summer of 2010. Low salinities in these basins resulted from the operation of the Davis Pond Diversion (Barataria Basin) and the Caernarvon Diversion (Breton Sound Basin). Both diversions were opened to allow Mississippi River water to flow in the basins and keep oil from the DWH event from penetrating the estuaries. Breton Sound Basin sampling showed an overall mortality of 77 percent. Mortality on private leases that are primarily located in the upper basin showed an overall mortality of 85.6 percent as compared with 56.3 percent mortality on public grounds that are mostly located downbasin.

Basinwide mortality in the Barataria Basin was estimated at 32.5 percent with mortalities being fairly evenly distributed across public and private grounds. Upbasin locations showed more mortality than downbasin stations with one downbasin station in Bay Jacques, located near the mouth of the Mississippi River, showing 100 percent mortality. The Bonnet Carré Spillway was opened between May 9 and June 20, 2011, to allow Mississippi River water to flow through Lakes Pontchartrain and Borgne into Mississippi Sound. In Mississippi Sound, the percent oyster mortalities between samplings in May and June increased at Pass Christian (16% to 54%), at Pass Marianne Reef (18% to 43%), and at St. Joseph's Reef (7% to 99%); these increases were apparently caused by low salinity. Sacks per acre decreased from 448 to 36.4 at Pass Christian Complex, from 91 to 43.8 at Pass Marianne Reef, and from 121 to 2.7 at St. Joseph's Reed. Telegraph Reef was apparently unaffected with mortalities, dropping from the May level of 40 percent to the July level of 36 percent, and the sacks per acre rose from 8.1 in May to 15.5 in July (Gordon, official communication, 2011). The State of Mississippi is seeking a Federal fisheries disaster declaration for the State's oyster reefs and shrimp populations because of the freshwater releases (Mississippi Dept. of Marine Resources, 2011a).

Seventeen bays of the Morganza Floodway were opened between May 14 and June 24, 2011, to allow fresh water to flow into the Atchafalaya Basin. The effects of the fresh water on oyster mortalities in southeastern Louisiana and the mortalities on the beds in the southern portion of the Atchafalaya Basin are currently unknown; however, given the species' intolerance for freshwater, it appears that the recent opening on the floodways will result in further mortalities and stresses to the species. The Louisiana Dept. of Wildlife and Fisheries is conducting sampling in potentially affected areas, and the results will be incorporated as they become available.

The NMFS reports each year to the Congress and Fishery Management Councils on the status of all fish stocks in the nation. As of the 2010 status report (USDOC, NMFS, 2011i), overfished species in the

GOM are red snapper, greater amberjack, gag grouper, and gray triggerfish. Each of these species is discussed in detail in **Chapter 4.1.15.1**. Overfished is defined as a stock size that is below a prescribed biomass threshold (or the population is too low).

Economics of Commercial Fisheries

The commercial fishing industry is an important component to the economy of the Gulf of Mexico. **Table 4-17** provides an overview of the economic significance of the commercial fishing industry in the Gulf of Mexico (USDOC, NMFS, 2011g). Commercial fishing landings in the Gulf were worth over $629 million in 2009. Louisiana had the highest catch value with over $280 million, Texas and Florida each had over $100 million in landings, and Alabama and Mississippi each had around $40 million in landings. Detailed information regarding the catch rates and prices paid for individual species in each Gulf Coast State can be obtained through NMFS's economics report (USDOC, NMFS, 2011g).

Landings revenue also supports economic activity along the commercial fishing supply chain. **Table 4-17** presents estimates of sales and employment in the economy that depends on commercial fishing activity. Approximately $17 billion in combined sales activity and approximately 128,000 jobs depend directly or indirectly on commercial fishing in the GOM. Of the Gulf Coast States, Florida has the highest level of overall commercial fishing-dependent jobs due to a large number of seafood importers, retail outlets, and seafood distributors located in the state. Louisiana has approximately 29,000 jobs in the industry, while Alabama and Mississippi each have fewer than 10,000 jobs. The USDOC, NMFS (2011g) also provides more detailed breakdowns of sales and employment statistics in each Gulf Coast State. The final column of **Table 4-17** presents the commercial fishing quotient, which is a measure of the concentration of the fishing industry in a particular state relative to the national average. Louisiana has the highest commercial fishing quotient in the Gulf of Mexico; its commercial fishing quotient of 2.19 means that the concentration of the fishing industry in Louisiana is 2.19 times that of the U.S. average. Texas and Alabama have the lowest commercial fishing quotients in the Gulf; the concentration of the commercial fishing industry in these states is less than half of the national average.

The DWH event has had a number of effects on the commercial fishing industry. The most direct manner in which the spill affects the industry is through the potential for decreased harvests of a number of species over the next few years. While, at this time, there exists substantial uncertainty regarding the range and magnitude of these effects, Greater New Orleans, Inc. (2011) attempts to create estimates of the economic effects of lower harvests on the economy of the Louisiana. This study first estimates harvest losses of certain species over the next 3 years. It then uses available price information to compute a range of possible revenue losses for the industry. It estimates that revenue losses in Louisiana could be between $115 million and $173 million over the next 3 years. The Greater New Orleans, Inc. also attempts to estimate the broader economic implications from these potential revenue losses. Namely, losses in fishing harvests cause reduced revenue throughout the commercial fishing supply chain. In turn, this lower revenue reduces the income of workers in the commercial fishing industry, which reduces their spending on a broader range of goods and services. Based on this "multiplier" effect, Greater New Orleans, Inc. estimates that total output losses resulting from these effects could be between $285 million and $427 million over the next 3 years.

The DWH event has also affected the financial condition of the workers and firms who work in the commercial fishing industry. A number of workers were idled during the spill and during the subsequent State and Federal commercial fishing bans. Some of these workers were hired by BP as part of the Vessel of Opportunity program. While this work led to reasonably high income to some workers, it created a divergence among the financial conditions between those who were hired by the program and those who were not (Davidson, 2010). In addition, even though some fishermen were helped by the Vessel of Opportunity program, businesses further up the supply chain had fewer alternative options and thus suffered due to the closures. Payments from BP also helped mitigate the financial damage to some individuals and businesses to some extent; as of March 5, 2012, $134 million in damage claims had been paid to individuals and $609 million had been paid to firms in the fishing industry in the GOM (Gulf Coast Claims Facility, 2012).

The long-term economic implications of the DWH event on the commercial fishing industry remain unclear. In part, this is due to uncertainty regarding the fate of fish species in the GOM (**Chapter 4.2.1.18**). However, it will also take some time to determine the speed and extent to which confidence in the seafood industry in the GOM will be restored. Preliminary evidence suggests that the general public became wary of consuming seafood from the Gulf of Mexico as the spill progressed. For example, Greater New Orleans, Inc. (2011) provides survey evidence regarding the impacts of the DWH event on public perceptions of seafood originating from the Gulf of Mexico. This study found that, subsequent to the DWH event, 69 percent of seafood restaurant owners nationwide reported a significant number of questions from customers regarding the origin of the seafood they serve. This study also found that, following the DWH event, 50 percent of restaurant customers had a negative opinion of seafood originating from Louisiana. It is likely that confidence in the seafood industry will gradually return if Gulf seafood can be demonstrated to be safe. Indeed, BP has given Louisiana $18 million for seafood monitoring and $30 million for seafood promotion programs. The Federal Government also has programs in place to monitor the safety of seafood obtained from reopened fishing areas. Information regarding these testing programs and their findings can be found at the U.S. Dept. of Health and Human Services, Food and Drug Administration (2011), and USDOC, NOAA (2011g). These testing programs have generally found that seafood from Gulf waters is safe. However, Wilkinson (2011) provides a summary of some of the longer-term concerns regarding the impacts of the oil spill on the fishing industry in the Gulf of Mexico.

Despite the publication of the preliminary studies cited above, there remains incomplete or unavailable information regarding the effects of the DWH event on commercial fishing and the species on which the industry depends. Here, BOEM concludes that the unavailable information from this event may be relevant to foreseeable significant adverse impacts to the commercial fishing industry. Relevant data on the status of the industry and commercially important fish populations after the DWH event may take years to acquire and analyze through the NRDA process and other studies, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches.

4.2.1.19.2. Impacts of Routine Events

Background/Introduction

Direct effects on commercial fishing from routine offshore activities could result from the installation of production platforms, and underwater OCS obstructions including pipelines, production platform removals, seismic surveys, and the discharge of offshore waste. Offshore structures can cause space-use conflicts with commercial fishing, especially with longline fishing. Exploratory drilling rigs cause temporary interference to commercial fishing, lasting approximately 30-150 days. Major production platforms present a permanent area unavailable for fishing that includes structures and safety zones. Underwater OCS obstructions such as pipelines can cause loss of trawls and catch, as well as fishing downtime and vessel damage.

Production platform removal in water depths <200 ft (61 m) removes artificial reef habitat and often involves the use of explosives. This is lethal to fish that have internal air chambers (swim bladders), are demersal, and are in close association with the structure or are transitory in the area. Intense sounds generated by seismic surveys affect the spatial distribution of fish during and for some period following exposure. Intense sounds generated by seismic surveys affect the spatial distribution of fish during and for some period following exposure. These impacts are limited to the immediate area of the decommissioning activity and to those fish that happen to be at the platform at the time of the use of explosives. As such, these impacts are limited geographically and temporally, and these impacts would not be expected to rise to population-level impacts.

The effects of seismic surveys are difficult to assess in open waters. In a report to the Norwegian Oil Industry, Gausland (2003) summarized seismic studies to date and the complaints of commercial fishermen. He concluded that seismic surveys may have behavioral influences on fish. The radius of that effect will depend on many variables, including sea conditions, food supply, and the species of fish. Gausland also concluded that the maximum distance of behavioral impact was less than 2 km (1.2 mi).

In 2005, this Agency issued a programmatic environmental assessment of structural removal operations in the Gulf of Mexico (USDOI, MMS, 2005) and, after review, considered the overall impacts of structural removals by explosives on commercial fishing to be low and generally offset by the rigs to reefs program. The most commonly discharged offshore wastes are drill mud and produced water. Drill mud contains metals such as mercury and cadmium, which are toxic to fishery resources. Produced water commonly contains brine, trace metals, hydrocarbons, organic acids, and radionuclides. Any or all of these constituents, in high enough concentrations, can be toxic to fish at any stage of their life cycle. Drilling mud plumes; however, the have been shown to disperse rapidly to very near background levels at a distance of 1,000 m (3,281 ft) and they are usually undetectable at distances >3,000 m (9,843 ft) (Kennicutt, 1995). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling mud.

The toxicity of the metals associated with drilling mud also depends upon their bioavailability to organisms. Methylmercury is the bioavailable form of mercury (Trefry and Smith, 2003). In a study of methylmercury in sediments surrounding six offshore drilling sites, Trefry et al. (2003) found that methylmercury concentrations did not vary significantly between near-field and far-field sites. Further, Trefry et al. (2003) suggested that levels of methylmercury in sediments around drilling sites are not a widespread phenomenon in the Gulf of Mexico. The discharge of drilling mud is, therefore, not anticipated to contribute to fish mortality either through direct exposure to discharged drilling mud or resuspension of mud through wave action or dredging. Literature searches through referenced literature and Government documents did not produce any consistent results that indicated sublethal effects had been demonstrated in fisheries species.

Produced water commonly contains brine, trace metals, hydrocarbons, organic acids, and radionuclides. Any or all of these constituents, in high enough concentration, can be toxic to fish at any stage of their life cycle. Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m (3,281 ft) of the discharge point (CSA, 1997). Produced water has not been shown to cause fish mortality in populations surrounding platforms. Produced water dilutes rapidly after discharge and it is usually discharged near the surface so that the dilution factor is maximized. In addition, the discharge of produced water is regulated by the U.S. Environmental Protection Agency's NPDES permits. Although sublethal effects have been observed in laboratory bioassays of sea urchins (Krause et al., 1992), no general sublethal effects have been reported in fisheries species in the Gulf of Mexico.

Additionally, routine OCS activities may impact inshore commercial fisheries indirectly. These activities include the construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, and inshore disposal of OCS-generated, petroleum-field wastes. Marine environmental degradation resulting from routine offshore activities also has the potential to indirectly affect commercial fish resources by reducing food stocks in soft-bottom and reef habitats. These routine activities include the offshore discharge of produced water and drilling mud.

Degradation of coastal water quality may indirectly impact commercial fisheries. Coastal water quality may be affected adversely by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. These factors potentially also affect the quality and quantity of wetlands and the quality of estuaries. Many commercial fish in the offshore Gulf of Mexico depend on these resources as nursery habitat. Trash, discharges, and runoff may be released from onshore facilities and vessel traffic, and they may cause degradation of coastal water quality. Besides coastal sources, trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions. Marine environmental degradation resulting from routine offshore activities also has the potential to indirectly affect commercial fish resources by reducing food stocks in soft-bottom and reef habitats. These routine activities include the offshore discharge of produced water and drilling mud.

Proposed Action Analysis

The routine activities associated with a CPA proposed action that would impact commercial fisheries include the installation of production platforms, underwater OCS obstructions, pipeline trenching, production platform removals, seismic surveys, and the discharge of offshore waste.

Commercial fisheries conflicts with platforms in water deeper than 200 m (656 ft) are limited to the longline fishery. Surface-drifting longlines may contact a deepwater platform if not set an appropriate distance from the surface-piercing structure. The area of a surface-piercing structure is very small in relation to the total area available to longliners.

The number of kilometers of pipeline projected to be emplaced in the CPA in water depths <60 m (200 ft) is from 134 to 364 km (82 to 226 mi). Because of pipeline burial requirements, it is assumed that installed pipelines would seldom conflict with bottom trawling activities in water depths <60 m (200 ft), and it would not conflict with commercial fishing in deeper waters.

Structural removals in water depths <200 m (656 ft) result in a loss of artificial habitat and in fish mortality when explosives are used. It is projected that 28-54 removals would result in the CPA in water depths <200 m (656 ft) as a result of a CPA proposed action, making approximately 2,184-4,212 ha (5,397-10,408 ac) available again for commercial fishing. It is expected that structure removals would have a negligible impact on commercial fishing because of the small number of removals and the consideration that removals kill primarily those fish associated with the platforms or those transient in the area.

Seismic surveys would occur in both shallow and deep waters of the CPA. Seismic survey vessels are of temporary presence in any commercially fished area of the CPA. Temporal and spatial distributions of commercial species are not affected in areas adjacent to seismic surveys. The locations and schedules of seismic surveys are published in the USCG's "Local Notice to Mariners." Seismic surveys have a negligible impact on commercial fisheries because surveys are limited in time and space, and the observed fish response is to avoid the area of the survey for a short period of time. As such, these impacts would be limited to a small area and a matter of days.

Produced water and drill mud are discharged in shallow and deep waters of the CPA. Studies of drill mud and produced water from platforms show that the plume disperses rapidly in both cases and does not pose a threat to commercial fisheries. In a recent study of the concentrations of the bioavailable form of mercury (methylmercury) in drill mud, Trefry et al. (2003) found concentrations did not vary significantly between near-platform and far-platform sites (e.g., it is not significantly different from background concentrations). Further, the study suggested that elevated levels of methylmercury in sediments around drilling sites are not a widespread phenomenon in the Gulf of Mexico (Trefry et al., 2003). As such, any impact to commercial fisheries would likely be indistinguishable from exposure to background concentrations.

Despite the publication of some data since the DWH event, there remains incomplete or unavailable information regarding the effects of the DWH event on commercial fishing and the species on which the industry depends. The BOEM concludes that the unavailable information from this event may be relevant to a full understanding of the impacts to the commercial fishing industry; however, given the available data that have been released, BOEM believes that the incomplete or unavailable information is not essential to a reasoned choice among alternatives.

Relevant data on the status of the industry and commercially important fish populations after the DWH event, particularly if there are any disruptions to reproduction or life cycles, may take years to acquire and analyze through the NRDA process and other studies, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches.

Summary and Conclusion

Routine activities such as seismic surveys and pipeline trenching in the CPA would cause negligible impacts and would not deleteriously affect commercial fishing activities. Because seismic surveys are temporary events, they are not expected to cause significant impacts to commercial fisheries. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal would cause displacement of commercial fishing while operations are ongoing. These effects are localized to a small percentage of the area fished and they are temporary in nature.

Studies of drill mud and produced-water discharges from platforms show that the plume disperses rapidly in both cases and does not pose a threat to commercial fisheries. Routine activities are therefore not considered a threat to the commercial fisheries of the Gulf of Mexico.

4.2.1.19.3. Impacts of Accidental Events

Background/Introduction

Accidental events that would impact commercial fisheries include subsurface offshore blowouts and oil spills, both inshore and offshore. There is a small risk of spills occurring during shore-based support activities. The great majority of these would be very small. Most of these incidents would occur at or near pipeline terminals or shore bases, and they are expected to affect a highly localized area with low-level impacts. The effects of accidental events on fish populations are described in **Chapter 4.2.1.18.3**.

Accidental events may have economic impacts on commercial fishermen if the event was large scale or long lasting, resulting in extensive closures such as for the DWH event. These events are, however, rare.

Proposed Action Analysis

The accidental events that would impact commercial fisheries include well blowouts, primarily gas well blowouts, and/or oil spills. Impacts of gas well blowouts on commercial fisheries are generally very localized and limited. Sediment redistribution would affect only the area within a few hundred yards of the blowout. Impacts of oil or oil/gas mixture blowouts may affect commercial fisheries populations, depending on their exposure to the oil, the type of oil, and the time of year of the spill. Most commercial species are only affected if the oil reaches the shelf or the inshore estuarine waters where they spend a portion of their life cycle.

Commercial fishermen would actively avoid the area of a small spill, but they may be prevented from fishing by State or Federal agency closures in some areas in the case of larger spills. Fish flesh tainting (oily tasting fish/shellfish) and resultant area closure could decrease commercial landings, value, or catch in the short term. Perception of tainting of commercial catches may affect the ability of commercial fishermen to sell their product.

Closure areas imposed by State or Federal agencies may also impact the commercial fisheries positively in the long term by easing fishing pressure on commercially (especially annually) harvested populations.

The effects of the DWH event on commercial fisheries are preliminary and mostly speculative. Data are lacking, and it will take several years to analyze specific long-term effects of the DWH event on all Gulf of Mexico commercial fisheries populations. There remains incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on commercial fishing. Much of this information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data that have been released, as described in this section, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives.

Blowout and Oil-Spill Impacts

A subsurface blowout event, although highly unlikely, has the potential to affect fish within a few hundred feet of the blowout. A blowout at the seafloor can cause a crater that might interfere with longlining in the near vicinity or cause an area to be closed to longlining. A seafloor blowout could also result in a localized increase in suspended sediments. These sediments can clog finfish gills and interfere with respiration. Sediments remaining in suspension can cause interference in feeding in finfish species that are sight feeders. Coarse sediments such as sand-sized particles, however, fall out of the water column quickly, but finer sediments are redistributed by currents and settle out over a larger area.

Oil spills may occur from blowouts; however, most product loss from blowouts is natural gas, primarily methane, which rapidly dissolves in the water column or escapes into the air. Recently published research (Kessler et al., 2011) revealed that a large amount of methane was released by the DWH event and, based upon the methane and oxygen distributions measured at 207 stations in the affected area, a large amount of oxygen was respired by methanotrophs. Kessler et al. (2011) suggest that the methane triggered a large methanotroph bloom that rapidly degraded the methane, leaving behind a residual methanotrophic community. Any impacts are expected to have been temporary, and in general, fish, including commercial stocks, typically avoid areas of low dissolved oxygen.

Most of the commercial fish and shellfish harvested in the CPA are estuarine dependent at some point in their life cycles. These include brown shrimp, white shrimp, pink shrimp, blue crabs, croaker, sheepshead, menhaden, black drum, red drum, spotted sea trout and sand sea trout. Oysters are most abundant in estuarine areas. Other species such as red snapper and king mackerel are most abundant on the shelf.

Oil spilled in the offshore areas is usually localized and has a very low probability of reaching shelf waters and coastal estuaries. Much of the oil volatilizes or is dispersed by currents in the offshore environment. Oil that is not volatilized, dispersed, or emulsified by dispersants, and through a combination of oceanographic and meteorological factors moves onto the shelf or into the estuaries and has the potential to affect finfish through direct ingestion of hydrocarbons or ingestion of contaminated prey. Impacts of oil spills can be via hydrocarbon uptake of prey, direct exposure of dissolved petroleum products through the gills and epithelium of adults and juveniles, decreased survival of larvae, and death of eggs (NRC, 1985 and 2002a).

Actual effects of any oil that is released and comes in contact with the shelf or estuarine populations of commercially important species will depend on the API gravity of the oil, its ability to be metabolized by microorganisms, and the time of year of the spill. Effects on the populations would be at a maximum during the spawning season of any commercially important population, exposing larvae and juvenile to oil. Effects on commercial species may also include tainting of flesh or the perception of tainting in the market. This can, depending on the extent and duration of the spill, affect marketability of commercial species.

The effects on future generations of commercial fisheries depend on the mobility of the species, sensitivity to contamination, and the length of their life cycles. Sessile species such as oysters would be affected more than species with the ability to avoid the oil. Species with short life cycles such as shrimp and crabs are most vulnerable because they are essentially an annual crop. Longer-lived species such as snapper and grouper have more resilience because these populations consist of multiple year classes that can breed, and the failure of any one year class does not necessarily threaten the survival of the population.

Closure areas imposed by State or Federal agencies may impact the commercial fisheries of an area either inshore in State waters or in the Exclusive Economic Zone by easing fishing pressure on commercially harvested populations. Most of these short-lived, estuarine-dependent species, such as brown and white shrimp and blue crabs, are harvested on an annual basis. Closure to harvest relieves the annual fishing pressure and, assuming no devastation of the population due to the effects of oil, may actually increase population levels during the period of closure.

Recent data collected by Dauphin Island Sea Lab researchers from stations outside of the barrier islands and inside of the estuaries prior to and after the DWH event and resulting spill show a clear increase in biomass and abundance of estuarine species such as Atlantic croaker, spot, shrimp, and crabs (i.e., post-DWH spill). Species studied were most abundant in the estuaries (as compared with outer barrier island stations) both pre-and post-spill. These data also show that the ratio between the total abundance of shrimp and crabs to Atlantic croaker and spot exhibited a huge decrease in the ratio after the spill (Valentine, official communication, 2010). Area closure may, therefore, have a somewhat positive impact on certain inshore commercial fisheries populations, even in the context of an accidental event.

Closure areas imposed by State or Federal agencies may also impact the commercial fisheries positively in the long term by easing fishing pressure on commercially (especially annually) harvested populations.

The effects of a catastrophic event, such as the DWH event, on commercial fisheries are preliminary and mostly speculative at this point. Data are unavailable, and it may take several years to acquire the necessary data and analyze it regarding long-term effects of the DWH event on all Gulf of Mexico commercial fisheries populations. There remains incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on commercial fishing. Much of this information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data that have been released, as described in this section, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives because catastrophic events remain extremely low-probability events (**Appendix B**).

Summary and Conclusion

Fish populations may be impacted by an oil-spill event should it occur, but they would be primarily affected if the oil reaches the productive shelf and estuarine areas. The probability of an offshore spill impacting these nearshore environments is also low, and oil would generally be volatilized or dispersed by currents in the offshore environment. Extent of the impacts of the oil would depend on the properties of the oil and the time of year of the event. Commercial fishermen are anticipated to avoid the area of a well blowout or an oil spill. Fisheries closures may result from a large spill event. These closures may have a negative effect on short-term fisheries catch and/or marketability. They may have a positive impact on annually harvested species in the longer term because there was a decrease in fishing pressure on the stocks

In summary, the impacts of a CPA proposed action from accidental events (i.e., a well blowout or an oil spill) are anticipated to be minimal for most fish and shellfish populations because the potential for oil spills is very low, the most typical events are small and of short duration, and the effects are so localized that fish are typically able to avoid the area adversely impacted.

4.2.1.19.4. Cumulative Impacts

Background/Introduction

Specific types of impact-producing factors considered in the cumulative analysis include the following: (1) commercial fishing techniques or practices; (2) wetland loss; (3) hurricanes; (4) installation of production platforms and underwater OCS obstructions; (5) production platform removals; (6) seismic surveys; (7) petroleum spills; (8) subsurface blowouts; (9) pipeline trenching; and (10) offshore discharges of drilling mud and produced waters..

Commercial Fishing Practices

There is competition among large numbers of commercial fishermen, among commercial operations employing different fishing methods, and between commercial and recreational fishermen for a given fishery resource. That competition, coupled with natural phenomena such as hurricanes, hypoxia, and red or brown tides, can impact commercial fishing activities. When practiced nonselectively, fishing techniques such as trawling, gill netting, or purse seining may reduce the standing stocks of the desired target species. This can also significantly affect species other than the target. In addition, continued fishing of most commercial species at the present levels can result in rapid declines in the landings and the eventual failure of certain fisheries.

Overfished species in the Gulf of Mexico, as defined by USDOC, NMFS (2011i), include the gag grouper, greater amberjack, red snapper, and gray triggerfish. These species are discussed in **Chapter 4.2.1.18.1**, and their decline is the result of overfishing or bycatch from the shrimp industry (red snapper).

Wetland Loss

The most serious impact to commercial fisheries is the cumulative effects on wetlands that are occurring at an ever-increasing rate. This is primarily from the population increase, and associated development relating to this population increase, of the Gulf Coast States and from the recent effects of major storms on wetland loss. Wetland conversion to open water would result in a permanent loss of nursery and foraging habitat for many commercial fish stocks. In comparison to the large area of wetland loss to commercial and recreational (such as marinas and camps) development, as well as to natural forces such as hurricanes, any incremental wetland loss due to a CPA proposed action would be minimal.

Hurricanes

Hurricanes may impact commercial fishing by damaging gear and shore facilities and by dispersing resources over a wide geographic area. Hurricanes may also affect the availability and price of key supplies and services (e.g., fuel) that also affect commercial fishing. Hurricanes suspend fishing activity and are destructive to wetlands that act as nursery grounds to many commercial fish. Hurricanes can be extremely destructive to oyster beds by causing siltation over the beds and smothering spat along with adult oysters, as evidenced by Hurricanes Katrina, Rita, Gustav, and Ike. Commercial fisheries landings of the central Gulf Coast were drastically impacted by Hurricanes Katrina and Rita in 2005 as a result of the severe impact on coastal port facilities and fishing vessels. Equally as destructive were Hurricanes Gustav and Ike in 2008. These impacts were so severe that Commerce Secretary Gutierrez determined a fisheries resource disaster as a result (Upton, 2010). However, natural disaster impacts such as these are easily distinguished from incremental impacts of OCS activities.

Installation of Production Platforms and Underwater Obstructions

A CPA proposed action is anticipated to result in the installation of 35-67 new production facilities (**Table 3-3**). These productions facilities compete with commercial fishing interests for physical space in the open ocean. The facilities can also be associated with underwater OCS obstructions that pose hazards to fishing nets. These facilities are also known fish attracting devices, so fish often congregate around them for food and shelter from predators. The area occupied by these structures is small compared with the area available in the CPA for fishing. Because the footprint area of OCS structures is small and easily avoided by fishing vessels, the cumulative impact of a CPA proposed action to the commercial fisheries of the CPA is anticipated to be small.

Platform Removals

Offsetting the anticipated installation of platforms in the CPA is the anticipated removal of 32-61 existing platforms (**Table 3-3**). The removal of these platforms not only frees the area for commercial fishing but also removes them as fish-attracting devices. There is the possibility the structures can be used in a rigs-to-reefs program where they would serve as artificial habitat for fish. Of those estimated to be removed, 20-40 are anticipated to be removed using explosives (**Table 3-3**). Explosives do cause mortality in fish with swim bladders when they are either associated with the platform or transient in the area at the time of the explosions, but these impacts would be localized to the immediate area of concern and would be short term. Because the number of platform removals is small, the effects on commercial fishery populations are expected to be minimal.

Seismic Surveys

Seismic surveys are used in both shallow- and deepwater areas of the Gulf of Mexico. Seismic surveys are limited in time and space, and the observed fish response is to avoid the area of the survey for a short period of time. Although it has been alleged that catch rates are lower after seismic surveys, fishermen are usually precluded from the area for several days. This should not significantly affect the annual landings or the value of landings for commercial fisheries because Gulf of Mexico species are found in many adjacent locations and because Gulf commercial fishermen do not fish in one locale.

Petroleum Spills

The potential causes, sizes, and probabilities of petroleum spills that could occur during activities associated with a CPA proposed action are discussed in detail in **Chapter 3.2.1**. Up to one large (≥1,000 bbl) offshore spill is estimated to occur annually from all sources Gulfwide (**Chapter 3.2.1.5.1 and Table 3-12**). Large spills can potentially affect commercial fisheries resources by causing potential losses to commercial fish populations. The effects of a catastrophic spill such as the DWH event, although based on limited data at this time, are discussed in **Appendix B**. Although the effects can be significant from any one spill, the overall probability of a large spill occurring is still low.

The majority of coastal spills in the Gulf (90%) are expected to be small (<1 bbl) and to cause a minimal decrease in commercial fishing local to the spill area. Because these spills are small, the resultant influence on commercial fishing, landings, or the value of those landings is not expected to be distinguishable from natural population variations.

Subsurface Blowouts

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to adversely affect commercial fishery resources. The loss of well control and resultant blowouts seldom occur in the Gulf OCS over a 40-year time period (169-197 blowouts out of 28,191-32,832 wells drilled; i.e., <1%). Sandy sediments are quickly redeposited within 400 m (1,312 ft) of a blowout site, and finer sediments are widely dispersed and redeposited within a few thousand meters or feet over a period of 30 days or longer. These events are expected to have a negligible impact on fish populations. It is expected that the infrequent subsurface natural gas blowout that can occur on the Gulf of Mexico OCS would have a negligible effect on commercial fish resources.

Subsurface blowouts, such as the DWH event, that include both oil and natural gas have the potential to affect fish populations particularly eggs, larvae, and juveniles. The specific effects of this type of spill on individual fish populations in the Gulf of Mexico are currently unknown, and spills of this type are a low-probability event. Because these spills are a low-probability event, the contribution of blowouts to the cumulative impact on commercial fisheries populations is not expected to be large as a result of a CPA proposed action.

Pipeline Trenching

Pipeline trenching also has the potential to affect commercial fisheries as a result of sediment suspension. Sandy sediments from either source are quickly redeposited within 400 m (1,312 ft) of the trench, and finer sediments are widely dispersed and redeposited over a period of hours to days within a few thousand meters of the event. No significant effects to commercial fisheries are anticipated as a result of oil or gas well blowouts or pipeline trenching. Resuspension of vast amounts of sediments as a result of large storms and hurricanes occurs on a regular basis in the northern Gulf of Mexico (<50 m; 164 ft) (Hu and Muller-Karger, 2007). In many areas of the Gulf of Mexico, sediments are not static under natural conditions, as evidenced by the recently discovered deep-sea furrows (Bryant et al., 2004).

The cumulative effect on commercial fisheries from oil and gas well blowouts in the Gulf OCS and pipeline trenching is not expected to be distinguishable from natural events or natural population variations.

Offshore Discharge of Drilling Mud and Produced Waters

Drilling mud discharges contain chemicals toxic to marine fishes, including brine, hydrocarbons, radionuclides, and metals. These concentrations are many orders of magnitude higher than those found more than a few meters or feet from the discharge point. Offshore discharges of drilling mud dilute to near background levels within 1,000 m (3,281 ft) of the discharge point and would have a negligible cumulative effect on fisheries.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Offshore discharges of produced water also disperses and dilutes to near background levels within 1,000 m (3,281 ft) of the discharge point and have a negligible cumulative effect on fisheries. Offshore live bottoms would not be impacted. Offshore discharges and subsequent changes to marine water quality are regulated by the U.S. Environmental Protection Agency’s NPDES permits.

Methylmercury is the bioavailable form of mercury. Biomagnification of mercury in large fish of higher trophic levels has often been perceived as a problem in the Gulf of Mexico. Biomagnification is often associated with drilling discharges, but the bioavailability and any association with trace concentrations of mercury in discharged drilling mud has not been demonstrated. Recent data suggest that mercury in sediments near drilling platforms is not in a bioavailable form.

The input of drilling mud and produced waters are limited and are diluted very quickly in the marine environment. Their environmental effects are, therefore, expected to be limited. Sampling results of methylmercury in the vicinity of OCS structures does not vary significantly from background concentrations.

Summary and Conclusion

In summary, there are widespread anthropogenic and natural factors that impact fish populations in the Gulf of Mexico. Wetland loss as a result commercial and residential development is one of the major factors in this trend, although this is regulated and mitigated by COE. The loss of wetland nutrient inputs into estuaries that form nurseries for many species and the loss of marsh and seagrass habitats that provides shelter for larvae and juveniles of many species is a major problem, particularly in the CPA. The loss of wetlands also contributes to the intrusion of saltwater into oyster-producing waters. This increases oyster mortality by increasing disease and predators in the oyster beds.

Inshore inputs of pollutants to estuaries from runoff and industry are also contributors to wetland loss. Resource management agencies, both State and Federal, set restrictions and permits in an effort to mitigate the effects of development projects, i.e., industry activities. The Federal and State governments are also funding research and coastal restoration projects; however, it may take decades of monitoring to ascertain the long-term feasibility of these coastal restoration efforts.

Overfishing (including bycatch) has contributed in a large way to the decline of some populations of Gulf of Mexico fish. The Magnuson-Stevens Fishery Conservation and Management Act and its amendments address sustainable fisheries and set guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities. Limits on catch and fishing seasons are set by the Gulf Coast Fisheries Management Council. State agencies regulate inshore fishing seasons and limits.

The OCS activities that may affect fish populations include a small contribution to wetland loss as a result of offshore traffic traversing inland canals. There is also a contribution from oil-related activities to inland waters and estuaries. Discharges from OCS activities such as drill mud and produced water have an incremental effect on offshore water quality. All discharges are regulated by the USEPA or State agencies.

Oil spills, although considered a rare event, can affect offshore waters. Adult fish are known to actively avoid areas of oil spills as they avoid any area of adverse water quality. The OCS factors can physically destroy live bottoms with anchors and anchor chains. These actions are mitigated by BOEM. The explosive removal of structures does have a negative effect on those fish in close proximity. The OCS activities such as the emplacement of structures and artificial reefs also have a positive effect by providing habitat and/or food for reef fishes.

The impacts of a catastrophic oil spill, such as the DWH event recently experienced in the Gulf of Mexico, based on limited data now available, are discussed in **Appendix B**. Unavailable information on the effects to commercial fisheries from the DWH event (and thus changes to the commercial fisheries baseline in the affected environment section) makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to the commercial fishing industry and commercially important fish resources. Relevant data on the status of commercially important fish populations and the commercial fishing industry after the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated by this NEPA analysis, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches. Nevertheless, BOEM believes that incomplete or unavailable information regarding the effects of the DWH event on the commercial fishing industry is not essential to a reasoned choice among alternatives in the cumulative effects analysis. The expected incremental effect of a CPA proposed action remains small, when viewed in light of other historic, ongoing and reasonably foreseeable future factors impacting commercial fishing, such as fishing pressures, habitat loss, and hurricanes described above.

The OCS factors potentially impacting fish resources in the Gulf of Mexico are federally regulated or mitigated and are small. There are many anthropogenic factors that are regulated by Federal and State agencies, and there are natural factors that cannot be regulated. Also to be considered is the variability in Gulf of Mexico fish populations due to natural factors such as spawning success and juvenile survival.

Overall, the commercial fish and shellfish populations have remained healthy in the Gulf of Mexico in spite of the OCS activities. In recent years, since 2005, the major contributors to the lower fisheries catches in the Gulf of Mexico have been hurricanes (Katrina, Rita, Gustav, and Ike), fisheries closures due to the DWH event, and freshwater diversions due to the DWH event and the Mississippi River flooding. Compared with non-OCS activities (such as commercial fishing practices, wetland loss, and hurricanes), the incremental effect of a CPA proposed action is not expected to be significant.

4.2.1.20. Recreational Fishing

A CPA proposed action could cause minor space-use conflicts and could have minor effects on fish populations that support recreational fishing activity. However, routine OCS activities can also enhance recreational fishing opportunities since oil platforms serve as artificial reefs for fish habitats. Small to medium spills are unlikely to substantially impact recreational fishing activity due to the short-term duration of their impacts and the likely availability of substitute fishing sites in a particular region. A large spill such as the DWH event can have more noticeable impacts to recreational fishing activity, as well as to individuals and firms that depend on angler spending. However, these effects can be mitigated to some extent through financial compensation and through policies of Federal and State fisheries management agencies. A CPA proposed action should not have large effects on recreational fishing activity since it does not substantially increase the likelihood of an additional low-probability catastrophic spill along the lines of the DWH event.

4.2.1.20.1. Description of the Affected Environment

A CPA proposed action has the potential to impact a number of recreational fishing areas in the Gulf of Mexico. This section discusses the baseline environment for recreational fishing along the coasts of Louisiana, Mississippi, Alabama, and Florida; the baseline environment for recreational fishing along the coast of Texas is described in **Chapter 4.1.1.17.1**. Data on effort and catch levels for the most often fished species is presented first. This is followed by a description of the interaction between recreational fishing activity and the broader economy of the region. Finally, an analysis of the effects of the DWH event on the recreational fishing industry is presented.

Catch and Effort Data

Table 4-67 presents data on the most commonly landed species by recreational fishermen in Louisiana, Mississippi, Alabama, and Florida. These data, along with the majority of the other data presented, comes from the NMFS online database. **Table 4-67** presents the total number of fish caught and the total landings weight of certain fish species from 2001 through 2009 in these four states (see the "*Deepwater Horizon* Event" section below for an analysis of 2010 recreational fishing data). In 2009, the most number of fish landings occurred for spotted seatrout, pinfish, red drum, sand seatrout, Atlantic croaker, and gray snapper. The species with the most total pounds landed in 2009 were spotted seatrout, red drum, sheepshead, red snapper, king mackerel, and black drum. The number of landings for most species has been somewhat stable over time. However, landings of species such as sand seatrout and Atlantic croaker have shown an uptrend in recent years, while landings of species such as striped mullet and cobia have exhibited a general downtrend. **Table 4-68** shows the percent of the catch in **Table 4-67** that occurred in ocean versus inland waters. As expected, these percentages are highly species dependent, ranging from almost 100 percent ocean-landed for dolphins and blackfin tuna to less than 10 percent for southern flounder and Atlantic croaker. This information is particularly relevant in light of the DHW event, which appears to have had a more pronounced effect on ocean-based recreational fishing.

Table 4-69 presents data from two sources regarding angler participation in the Gulf of Mexico. Panel A presents data from NMFS and shows the total number of anglers in 2009 for each of the Gulf States in three categories: coastal, noncoastal, and out-of-state. Coastal refers to anglers who are State residents of coastal counties, noncoastal refers to anglers who are State residents of noncoastal counties, and out-of-state refers anglers who are out-of-state residents. Florida has the largest number of recreational fishing participants. Florida's approximately 6 million anglers accounted for 78 percent of participants among the four Gulf States that participated in the surveys by NMFS. Louisiana has the second highest number of participants, followed by Alabama and Mississippi. Florida also has the highest percentage of out-of-state anglers, and Louisiana has the highest percentage of in-state anglers. Panel B presents 2006 participation data from the National Survey of Fishing, Hunting, and Wildlife Associated Recreation. The scales of the findings are reasonably similar, although the differences are certainly not negligible; other than different survey years, the causes of these discrepancies are not immediately clear.

Table 4-70 presents data on the number of angler trips taken in each state in the Gulf of Mexico in 2009 (see the "*Deepwater Horizon* Event" section below for an analysis of 2010 recreational fishing data). Angler trips in West Florida accounted for approximately 70 percent of the 22 million trips in the Gulf of Mexico. There were approximately 4 million trips in Louisiana, 1.7 million trips in Alabama, and 1.1 million trips in Mississippi. **Table 4-70** also breaks down these trips by location and mode. The three geographic locations for each state are inland, State ocean waters, and Federal ocean waters. The three modes of fishing are shore fishing, charter fishing, and private/rental fishing. Approximately 67 percent of all recreational fishing trips in the Gulf of Mexico are conducted inland; fishing in State ocean waters accounts for approximately 27 percent of angler trips; and fishing in Federal ocean waters accounts for approximately 6 percent of the trips. Ocean fishing is more prevalent in Alabama and West Florida, which comprise approximately 40 percent of the total number of trips in each state. Offshore fishing only accounts for about 5 percent of trips in both Mississippi and Louisiana. The bulk of ocean fishing in the Gulf of Mexico is conducted through either shore fishing (37%) or private rentals (59%). Charter fishing accounts for less than 5 percent of the total number of angler trips.

Economic Effects of the Recreational Fishing Industry

Recreational fishing activity can affect a regional economy in a number of ways. The most direct manner in which anglers affect the economy is through direct spending on fishing-related goods and services. This direct spending includes both trip expenditures and expenditures on durable equipment. Trip expenditures include such things as transportation costs, boat fees, and bait expenses. Durable purchases include spending on things such as fishing equipment and fishing boats. **Table 4-21** presents data on total direct spending by anglers in each state along the Gulf of Mexico. There was approximately $10.1 billion in direct spending by anglers in 2009; roughly half of this spending occurred in West Florida. Louisiana and Texas each had over $2 billion in spending, while Alabama and Mississippi each had over $400 million in spending.

Direct spending by fishermen also supports firms in related industries along an economy's supply chain. In addition, spending by fishermen serves as income to other agents in an economy, which supports overall spending patterns. The NMFS conducted an economic analysis that attempted to quantify this dependence of the regional economy on recreational fishing activity (USDOC, NMFS, 2011g); this analysis utilizes many of the techniques of an earlier study by Gentner and Steinbeck (2008). These studies utilize input-output economic models, which create multipliers that can be used to predict levels of sales, value added, and jobs that result from direct spending on recreational fishing. As can be seen in **Table 4-21**, direct spending by anglers supported approximately $9.8 billion in sales. One reason that sales are lower than spending is that only spending on newly produced goods contributes to economic activity (i.e., sales of used equipment does not). In addition, some spending that occurs by anglers would likely be replaced by spending by others if angler spending levels were to change. These sales contributed to $5.1 billion in value-added in the economy. While the sales data aggregates spending at different stages of production, value-added only includes the incremental production at each level in the supply chain. Finally, it is estimated that spending by anglers supports over 70,000 jobs in Louisiana, Mississippi, Alabama, and Florida.

Deepwater Horizon Event

The previous sections described the baseline environment for recreational fishing in the Gulf of Mexico prior to the DWH event. The DWH event had a number of impacts on recreational fishing activity. The most direct impacts of the spill on angler activities arose due to the closures of fishing areas in or near the oil-impacted areas. At the peak of its impact in June 2010, the oil spill led to the closure of 36.6 percent of the Federal waters in the Gulf of Mexico. All Federal waters have since been reopened to recreational fishing activity. A set of maps that depicts the areas closed to fishing activity at different times subsequent to the DWH event can be found at USDOC, NOAA (2011h). The NMFS continued to conduct angler surveys as the spill progressed. These data are presented in 2-month "waves" and thus provide a picture of the evolving state of recreational fishing in the Gulf of Mexico. **Table 4-71** presents data on the number of angler trips in each Gulf State for inland, State, and Federal waters in 2010; data for comparable months in 2009 are also presented. After the spill, the combined number of angler trips in Alabama, Florida, Louisiana, and Mississippi fell 10 percent in the May/June period and 15 percent in the

July/August period compared with the same months in 2009 (although the overall number of angler trips in these states between January and April in 2010 was also somewhat lower than in 2009). This decrease in angler activity was particularly pronounced in Federal waters. Overall angler activity in Federal waters fell 23 percent during the May/June period and 39 percent during the July/August period. Angler trips in State waters also fell in all states except Alabama. However, there was actually a noticeable increase in angler activity in the September/October period, particularly in inland waters. The overall number of angler trips in Federal waters also increased during the September/October period (compared with the same period in 2009), although angler activity in Louisiana and Mississippi remained quite limited. Angler activity moderated in the final months of 2010, perhaps suggesting that the pickup in activity in the September/October period was temporary. **Table 4-72** presents data on the species of fish caught for the same time periods as were presented in **Table 4-71** in order to provide an initial sense of the impacts of the spill on individual species. Landings for most species in the Gulf of Mexico fell only modestly after the oil spill. Species landings that fell more noticeably include gray snapper, red snapper, king mackerel, and red grouper.

While the previous data provide a useful picture of recreational activity as the spill progressed, there is more uncertainty regarding the long-term implications of the oil spill on recreational fishing. The most important determinant of the longer-term effects of the spill will be the manner in which the fish ecosystems in the Gulf of Mexico evolve in response to the spill. The IEM (2010) provides an overview of the factors that determine the extent to which some fish species will be able to adapt to the spill. However, one factor that makes these issues hard to gauge at this point is that, for many species, oil is more damaging to eggs and larvae than to adults. Thus, even if recreational fishing activity is maintained in the near term, it will take some time to observe if, and to what degree, the reproductive cycle of particular species has been impacted. Fish resources that are important in recreational fishing, and the effects and potential effects of the DWH event on these resources, are described in **Chapters 4.2.1.18 and 4.2.1.19**.

Impacts to the recreational fishing industry will also be determined by the ability of the people and firms in the industry to weather the current conditions. Fishing closures occurred during a normally strong period for recreational fishing. In addition, many firms that cater to recreational fishing are small and may lack the ability to weather the resulting lack of business. The IEM (2010) presents some survey results regarding the effects of the spill on local fishermen. While a number of fishermen in affected areas were idled directly after the spill, Louisiana officials opened a number of areas to recreational fishing in mid-July 2010 (Federal Reserve Bank of Atlanta, 2010). In addition, a number of people were supported short term by BP claims and by the Vessels of Opportunity Program. For example, businesses and individuals in the fishing industry have received over $743 million in compensation payments as of March 5, 2012 (Gulf Coast Claims Facility, 2012).

The fate of the recreational fishing industry will also depend on the extent to which confidence can be restored in the tourism and seafood industries along the Gulf Coast. This is a particularly hard issue to quantify at this point, in part because this issue will be determined by the success of government policy initiatives. For example, Louisiana will receive $78 million from BP to monitor seafood and to promote tourism. Thus, while a number of fishermen and businesses catering to them have been financially damaged by the spill, it appears that, if long-term impacts to recreational fishing do result from the DWH event, they will primarily be determined by the extent to which the fish ecosystems in the Gulf of Mexico are able to adapt to the spill over time.

Preliminary data from NMFS suggest that recreational fishing activity held up well during 2011. For example, NMFS estimates that there were 13.92 million angler trips in West Florida, 2.41 million angler trips in Alabama, 1.57 million angler trips in Mississippi, and 4.55 million angler trips in Louisiana during 2011. This means that the number of angler trips were actually higher in 2011 than in 2009 for Louisiana, Mississippi, and Alabama, while there were somewhat fewer angler trips in 2011 than in 2009 in West Florida (USDOC, NMFS, 2011j).

There remains incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on recreational fishing. Much of this information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM’s ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data that have been released, as described in this section, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives.

4.2.1.20.2. Impacts of Routine Events

Background/Introduction

Routine OCS actions can affect recreational fishing activity in a number of ways. The most direct impacts of OCS actions occur through their impacts on the fish populations that support recreational fishing activity. Many of the species fished by recreational anglers are the same as those caught by commercial fishermen. The main exception is menhaden, which is primarily a commercially fished species. The effects of routine OCS activities on commercial fishing are discussed in **Chapter 4.2.1.19.2**. The OCS activities can cause coastal environmental degradation either through effects on water quality or on wetland habitats. The effects of environment degradation on fish resources and essential fish habitat are discussed in detail in **Chapter 4.2.1.18.2**. Construction operations and vessel traffic could also cause some degree of space-use conflict with recreational fishing vessels. Since the majority of recreational fishing activity in the Gulf of Mexico occurs fairly close to shore, space-use conflicts would primarily arise near onshore ports (primarily during the construction phase). **Chapter 4.2.1.23.1** discusses the structure of the coastal infrastructure that supports OCS activities. However, even if a space-use conflict was to arise in a particular instance, it is likely that a number of substitute recreational fishing sites would be available.

Oil platforms are particularly important to the recreational fishing industry due to their unique role as artificial reefs for fish habitats. Oil platforms often act as fish-attracting devices and, as such, attract a large fish population due to their particular suitability as reef structures. The Atlantic and Gulf States Marine Fisheries Commissions (2004) provide more information regarding the features of oil and gas platforms that make them particularly supportive of fish populations. Hiett and Milon (2002) estimate that over 20 percent of all recreational fishing activity in the Gulf of Mexico occurs within 300 ft (91 m) of an oil and gas structure. The extent to which a rig will serve as an attractor to fish will depend on the fish populations in nearby areas. The NOAA’s Center for Coastal Monitoring and Assessment’s website provides a set of maps that outlines the areas in the Gulf of Mexico in which certain fish species are prevalent (USDOC, NOAA, 2011d). In general, rigs that are closer to shore are more likely to be supportive of recreational fishing activity.

Since oil/gas platforms often attract a large fish population, the effects of OCS actions become particularly important during the decommissioning stage of an oil platform’s life cycle. Namely, the removal of an oil rig from a particular site has the potential to damage the fish assemblages that often develop on an oil rig. This in turn will also affect recreational fishing activity in a particular area. Gitschlag et al. (2001) conducted an analysis of the impacts to fish populations from the use of explosives to remove decommissioned oil platforms. They found that species such as red snapper and sheepshead are particularly vulnerable to the use of explosives; however, they also reported that the scale of these impacts were relatively small at the sites that were included in the study.

As an alternative to removing an oil platform, the owner of an oil rig has the option to participate in the “Rigs-to-Reefs” program of the appropriate state. These programs allow for portions of oil platforms to remain in the water as reefs after the productive life of a platform has ended. Platforms that are a part of these programs are either toppled in place or are moved to a location that is a suitable fish habitat. Maps of artificial reef locations in the CPA can be found on the websites for the Louisiana Dept. of Wildlife and Fisheries (2011a), the Mississippi Dept. of Marine Resources (2011b), and the Alabama Dept. of Conservation and Natural Resources (2011a). The U.S. policy towards artificial reef creation is outlined in the *National Artificial Reef Plan: Guidelines for Siting, Construction, Development, and Assessment of Artificial Reefs* (USDOC, NOAA, 2007). The BSEE policy regarding Rigs-to-Reefs programs is outlined in *Rigs-to-Reefs Policy, Progress, and Perspective* (USDOI, MMS, 2000b) and was updated in *Rigs to Reefs Policy Addendum: Enhanced Reviewing and Approval Guidelines in Response to the Post-Hurricane Katrina Regulatory Environment* (USDOI, MMS, 2009c) in light of Hurricane Katrina.

Proposed Action Analysis

A CPA proposed action would lead to 35-67 oil and gas production structures (**Table 3-3**). This could lead to minor space-use conflicts with recreational fishermen, primarily during the construction phase. A CPA proposed action could also lead to some forms of environmental degradation that could affect fish populations, and this would also impact recreational fishing activity. These effects on fish populations are discussed in more detail in **Chapter 4.2.1.18.2**. However, these effects are expected to be minimal, particularly given the small scale of a CPA proposed action relative to the existing OCS oil and gas program.

The extent to which the proposed oil platforms will support recreational fishing activity will depend on their location. For example, oil rigs very far offshore are less likely to support recreational fishing activity. In addition, the extent to which oil platforms will hurt or harm recreational fishing populations after decommissioning will depend on the extent to which platforms will be maintained through Rigs-to-Reefs programs. Historically, slightly over 10 percent of oil rigs have participated in State Rigs-to-Reefs programs. The degree of participation in these programs is not projected to substantially change during upcoming years.

Summary and Conclusion

There could be minor and short-term space-use conflicts with recreational fishermen during the initial phases of a CPA proposed action. A proposed action could also lead to low-level environmental degradation of fish habitat (**Chapter 4.2.1.18.2**), which would also negatively impact recreational fishing activity. However, these minor negative effects would likely be offset by the beneficial role that oil rigs serve as artificial reefs for fish populations. The degree to which oil platforms would become a part of a particular State's Rigs-to-Reefs program would be an important determinant of the degree to which a CPA proposed action would impact recreational fishing activity in the long term.

4.2.1.20.3. Impacts of Accidental Events

Background/Introduction

The most direct manner in which oil spills and other accidental events would impact recreational fishing activity would be through their effects on fish and their habitats in the affected areas. A spill could either contaminate fish in the immediate area or cause fish to move during the duration of the spill. A spill would likely cause more direct harm to larvae and eggs than adults, which could possibly affect recreational species in the longer term. The effects of accidental events on fish resources and essential fish habitats are discussed in **Chapter 4.2.1.18.3**. The fish species most important to recreational fishing in certain regions are discussed in **Chapter 4.2.1.20.1**. A number of these species are similar to the species that are important to the commercial fishing industry; the effects of accidental effects on commercial fishing are described in **Chapter 4.2.1.19.3**. The large amount of recreational fishing activity in the Gulf of Mexico occurs in the bays and wetlands areas along the Gulf Coast; the impacts of accidental events on wetland areas are described in **Chapter 4.2.1.4.3**.

The effects of an oil spill on recreational fishing are different from those experienced by the commercial fishing industry in several ways. Most directly, the benefits received by anglers from fishing activity are determined by subtle issues such as the enjoyment of the fishing process and the aesthetics of a particular fishing site. As a result, the damage of an oil spill to recreational fishing will be determined by issues such as the availability of substitute fishing sites in a region and the additional costs of attending alternate sites. These effects are most often analyzed using a variety of mathematical modeling techniques; an overview of these techniques is presented by NRC (2006) and the European Inland Fisheries Advisory Commission (2010). The two primary types of methods to evaluate the impacts of changes to fisheries available to anglers are revealed preference models and stated preference models. Revealed preference models infer the value anglers attach to certain fishery attributes through their observed behavior, while stated preference approaches ask anglers how they would adjust their fishing behavior in hypothetical situations. The features of a particular fishing site that will determine its value to anglers include its travel distance, species densities, catch rates, and the level of support facilities. Haab et al. (2000 and 2010) and Greene et al. (1997) are examples of applications of these methods to fisheries in the Gulf of Mexico. The *Exxon Valdez* spill was an example of a spill that occurred in an area with a large recreational fishing industry. Carson and Hanemann (1992) provide an economic analysis of the direct recreational fishing losses due to the spill. This study arrives at a rough estimate of $31 million in damage due to the *Exxon Valdez* spill. However, this study also discusses the numerous sources of uncertainty in arriving at this estimate. Mills (1992) provides a more detailed description of the trends in recreational fishing activity in Alaska before and after the *Exxon Valdez* spill.

Any disruption to recreational fishing activity would also have broader economic implications to a particular geographic region. Disruptions to recreational fishing would affect boat launches, bait shops, and durable fishing equipment manufacturers. Gentner Consulting Group (2010) attempts to quantify the potential losses to State economies due to recreational fishing closures in light of the DWH event. This study uses the expenditure estimates and input-output modeling framework of Gentner and Steinbeck (2008) to derive a daily measure of the potential losses in the economy due to fishing closures in the Gulf of Mexico. This study estimates that the recreational fishing industry contributes $9.8 million in direct expenditures, $23 million in total sales, and 183 jobs per day to the economy of the Gulf of Mexico. One can estimate the cost of a spill by restricting these estimates to a particular region and then multiplying the daily estimates by the total duration of a fishing closure brought about by an oil spill. Having examined more recent information regarding the impacts of the DWH event, it appears that recreational fishing activity has held up reasonably well following the spill; more information regarding the impacts of the DWH event on recreational fishing can be found in **Chapters 4.1.1.17.1 and 4.2.1.20.1**. It is also possible that an oil spill's effects on the recreational fishing industry could have broader effects on tourism. Namely, the loss of recreational fishing options at certain locations could dissuade visitors from taking trips to an overall area. Similarly, recreational fishing may suffer in areas not directly affected by oil due to uncertainty or to misperceptions regarding the extent of the oil damage. Finally, it can be difficult to reschedule vacations or recreational fishing tournaments in light of a spill in a particular region. While these effects are difficult to quantify, the U.S. House of Representatives (2010) provides a descriptive overview of the tourism effects felt during the DWH event. Greater New Orleans, Inc (2011) conducted a survey-based study to determine the effects of perception on seafood and tourism in Louisiana. This study found that perceptions of fishing and seafood in Louisiana were more negatively impacted than perceptions of the region more generally. This particular impact of oil spills on perceptions of seafood would likely impact recreational fishing activity. However, the effects on recreational fishing activity are more complex than on commercial fishing since anglers are less focused on direct consumption of their catch. In particular, the aesthetic effects of fishing in waters that are perceived to be tainted will determine the extent to which anglers curtail their activities in areas in the vicinity of a spill.

Proposed Action Analysis

A CPA proposed action would result in an estimated 81-156 total (all depths) producing oil wells, 11-21 of which would be in waters <100 m (328 ft); 108-241 producing gas wells, 58-115 of which would be in waters ,<60 m (197 ft); and 35-67 installed production platforms, 28-54 of which would be in waters <60 m (197 ft) (**Table 3-3**). Wells and platforms in water depths <60 m (197 ft) are more likely to be attractive to recreational fishermen because of their distance from shore.

A spill at one of these sites would likely lead to recreational fishing closures in the immediate vicinity in the short term. Since oil rigs often are habitats for certain fish species, there could be noticeable impacts to the fish ecosystem in the area of a spill. As can be seen in **Table 4-67**, the most commonly fished species by anglers in the Gulf of Mexico include Atlantic croaker, pinfish, red drum, sand seatrout, sheepshead, and spotted seatrout. However, the most direct effects of an oil spill at an offshore oil structure would be on offshore fish species such as red snapper and king mackerel. The NOAA's Center for Coastal Monitoring and Assessment's website provides a set of maps that outlines the areas in the Gulf of Mexico in which certain fish species are prevalent (USDOC, NOAA, 2011d).

Summary and Conclusion

An oil spill will likely lead to recreational fishing closures in the vicinity of the oil spill. Small-scale spills should not affect recreational fishing to a large degree due to the likely availability of substitute fishing sites in neighboring regions. A large spill such as the one associated with the DWH event can have more significant effects due to the larger potential closure regions and due to the wider economic implications such closures can have. However, the longer-term implications of a large oil spill will primarily depend on the extent to which fish ecosystems recover after the spill has been cleaned.

There remains incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on recreational fishing. Much of this information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data that have been released, as described in this section, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives.

4.2.1.20.4. Cumulative Impacts

Background/Introduction

The cumulative impacts to recreational fishing activity will arise from a CPA proposed action, the existing OCS Program, and the expected progression of the recreational fishing industry in the Gulf of Mexico. These impacts would arise from the cumulative effects on fish resources in the Gulf of Mexico, which are discussed in **Chapter 4.2.1.18.4**. This chapter discusses the cumulative impacts of wetland loss, marine/estuary water quality degradation, damage to live bottoms, structure removals, petroleum spills, subsurface blowouts, pipeline trenching, and discharges of drilling mud and processed waters on fish resources. Because many of the recreationally sought fishes are also harvested commercially, a number of the cumulative impacts to the recreational fishing industry are similar to those of the commercial fishing industry. This is true even though recreational fishing is primarily confined to smaller, closer inshore areas of the Gulf of Mexico than commercial fishing. **Chapter 4.2.1.19.4** outlines the cumulative impacts to the commercial fishing industry of commercial fishing practices, hurricanes, installation of production and underwater obstructions, platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and the offshore discharge of drilling mud and produced waters. The cumulative impacts unique to recreational fishing activity would arise from State and Federal fisheries management plans, the role of oil platforms as artificial reefs, and the lingering impacts of the DWH event.

State and Federal Fisheries Management Plans

A CPA proposed action could have cumulative impacts to the extent to which it alters or interacts with State and Federal Fisheries Management Plans. Recreational fishing activity is highly regulated, primarily to ensure a sustainable fisheries population through time. This often takes the form of catch limits per trip and quotas for overall catch per species during a given season. Recreational fishing activity in Federal waters is governed by the Gulf of Mexico Fishery Management Council; their most recent policies are outlined in GMFMC (2011). Each State has its own guidelines for recreational fishing in State waters. State fisheries policies can be found at the websites for the Louisiana Dept. of Wildlife and Fisheries (2011b), Mississippi Dept. of Marine Resources (2010), Alabama Dept. of Conservation and Natural Resources (2011b), and Florida Fish and Wildlife Conservation Commission (2011b). Texas' fisheries policies are discussed in **Chapter 4.1.1.17.4**. Federal Fisheries Management Plans could exacerbate the impacts of OCS actions if both were to impact certain species or fishing sites. However, fisheries management plans could also serve to mitigate the effects of an oil spill since these plans are often designed to maintain stable fishing activity. For example, the GMFMC allowed for a supplemental red snapper season in October 2010 since red snapper catch was unusually low during the DWH event (GMFMC, 2010). This supplemental red snapper season was designed to allow the 2010 quota for red snapper catch to be reached.

Rigs-to-Reefs and Artificial Reef Development

A CPA proposed action would contribute to the existing role that oil platforms serve as artificial reefs for fish habitats. Hiett and Milon (2002) estimate that over 20 percent of all recreational fishing activity in the Gulf of Mexico occurs within 300 ft (91 m) of an oil and gas structure. The extent to which a rig will serve as an attractor to fish will depend on the fish populations in nearby areas. The NOAA's Center for Coastal Monitoring and Assessment's website provides a set of maps that outlines the areas in the Gulf of Mexico in which certain fish species are prevalent (USDOC, NOAA, 2011d). In general, rigs that are closer to shore are more likely to be supportive of recreational fishing activity.

Since oil/gas platforms often attract a large fish population, the effects of OCS actions become particularly important during the decommissioning stage of an oil platform's life cycle. Namely, the removal of an oil rig from a particular site has the potential to damage the fish assemblages that often develop on an oil rig. This in turn will also affect recreational fishing activity in a particular area. Gitschlag et al. (2001) conducted an analysis of the impacts to fish populations from the use of explosives to remove decommissioned oil platforms. They found that species such as red snapper and sheepshead are particularly vulnerable to the use of explosives; however, they also reported that the scale of these impacts were relatively small at the sites that were included in the study.

As an alternative to removing an oil platform, the owner of an oil rig has the option to participate in the "Rigs-to-Reefs" program of the appropriate state. These programs allow for portions of oil platforms to remain in the water as reefs after the productive life of a platform has ended. Platforms that are a part of these programs are either toppled in place or are moved to a location that is a suitable fish habitat. Maps of artificial reef locations in the CPA can be found on the websites for the Louisiana Dept. of Wildlife and Fisheries (2011a), the Mississippi Dept. of Marine Resources (2011b), and the Alabama Dept. of Conservation and Natural Resources (2011a). The U.S. policy towards artificial reef creation is outlined in the *National Artificial Reef Plan: Guidelines for Siting, Construction, Development, and Assessment of Artificial Reefs* (USDOC, NOAA, 2007). The BSEE policy regarding Rigs-to-Reefs programs is outlined in *Rigs-to-Reefs Policy, Progress, and Perspective* (Dauterive, 2000) and was updated in *Rigs to Reefs Policy Addendum: Enhanced Reviewing and Approval Guidelines in Response to the Post-Hurricane Katrina Regulatory Environment* (USDOI, MMS, 2009c) in light of Hurricane Katrina.

Deepwater Horizon *Event*

The DWH event may heighten the sensitivity of recreational fishing activity in the CPA to additional oil spills that may occur. This is because the fish populations in the Gulf of Mexico are still responding to the spill, the ultimate outcome of which is not yet clear (**Chapters 4.2.1.18 and 4.2.1.19**). The particular sensitivity of recreational fishing to the DWH event is also due to the complex manner in which recreational fishing activity and tourism interact. Namely, recreational fishing activity is one of a number of factors that draw tourists to a particular region. The high level of national attention focused on the DWH event suggests that future oil spills, even if smaller in scale, could raise greater concerns regarding recreational fishing in affected areas among tourists. While this effect may be offset by additional fishing by others, any decrease in fishing-based tourism could have broader impacts to a local economy.

There remains incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on recreational fishing. Much of this information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects may be years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data that have been released, as described in this section, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives.

Summary and Conclusion

The CPA proposed action and the broader OCS Program have varied effects on recreational fishing activity. The OCS Program has generally enhanced recreational fishing opportunities due to the role of oil platforms as artificial reefs. This effect depends importantly on the extent to which rigs are removed at decommissioning or are maintained through "Rigs-to-Reefs" programs. However, oil spills can have important negative consequences on recreational fishing activity due to the resultant fishing closures and longer-term effects oil spills can have on fish populations. This was evident during the DWH event, the effects of which are not yet certain. However, this type of catastrophic spill event is rare. The contribution of a CPA proposed action to these positive and negative cumulative effects would be minimal because of the relatively small amount of activity expected with a CPA proposed action. In addition, it is likely that Fisheries Management Plans of the Federal and State governments would serve to keep overall recreational fishing activity reasonably stable through time.

4.2.1.21. Recreational Resources

This chapter discusses the potential impacts of OCS oil and gas activities on resources that are particularly important to the local recreation and tourism economies in the CPA. Routine OCS actions in the CPA can cause minor disturbances to recreational resources, particularly beaches, through increased levels of noise, debris, and rig visibility. A small- to moderate-sized oil spill will likely cause short-term disruptions to recreational activities in the immediate vicinity of the spill. A large-scale oil spill, such as the DWH event, can cause broader impacts to local economies due to its impacts on tourism activities. However, the cumulative impacts of a CPA proposed action on recreational activities are likely to be small in scale since the proposed action is not expected to result in another catastrophic spill along the lines of the DWH event.

4.2.1.21.1. Description of the Affected Environment

A CPA proposed action has the potential to affect the diverse set of recreational resources located throughout the coast of the Gulf of Mexico. The Gulf Coast is one of the major recreational regions of the United States. The shorefronts along the coasts of Florida, Alabama, Mississippi, Louisiana, and Texas support activities such as beach visitation, marine fishing, and nature-based recreation. These recreational opportunities attract visitors from around the world to the region. As such, these recreational resources are integral components to the broader economy of the Gulf of Mexico, supporting activities such as restaurants, lodging, and transportation. This section discusses the baseline conditions for recreational resources along the coasts of Louisiana, Alabama, Mississippi, and Florida since these are the primary areas that could be impacted by a CPA proposed action; the recreational resources along the Texas coastline are discussed in **Chapter 4.1.1.18.1**. The economic significance of the recreation and tourism industries in the coastal zones of these states is presented first. This is followed by a more in-depth discussion of the structure of the recreational industries in Florida, Mississippi, Alabama, and Louisiana. The final section presents a discussion of the impacts of the DWH event on these states.

Economic Significance of the Recreational Industry in the Gulf Coast

The recreation and tourism industries are major sources of employment along the Gulf Coast. **Table 4-23** presents employment statistics for a set of geographic regions in the Gulf of Mexico. Panel A of **Table 4-23** presents data on the number of employees in the leisure/hospitality industry from 2001 through 2009 in 13 BOEM-defined EIA's; these regions are defined in **Figure 4-20**. (All employment data were obtained through the U.S. Dept. of Labor, Bureau of Labor Statistics.) In **Table 4-23**, the leisure/hospitality industry corresponds to the definition used by the North American Industrial Classification System; this definition includes sub-industries such as entertainment providers, lodging services, and food/beverage services. Panel A of **Table 4-23** shows that approximately 685,000 people worked in the leisure/hospitality industry in EIA's in Florida, Alabama, Mississippi, and Louisiana in 2009. FL-3 and FL-4 had the largest concentration of recreation employees, with a total of about 423,000 workers. LA-4 also has a sizable recreation industry, with over 67,000 workers. Most of the EIA's showed steady employment growth from 2001 through 2008; employment fell in all EIA's (except FL-1) in 2009 with the onset of the global economic downturn during that time. A notable exception to the steady growth experienced by most regions occurred in 2005 in LA-4 and MS-1. Hurricanes Katrina and Rita hit these two regions extremely hard, slashing tourism/recreation employment by almost half (the data presented is of December 2005; thus, the figure for 2005 should fully reflect the impact of Hurricane Katrina). Recreation employment in these regions has recovered a fair amount, although employment in 2009 is still below employment in 2004 in both LA-4 and MS-1 (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010a).

Panel B of **Table 4-23** presents the number of recreation/tourism employees in the EIA counties/parishes that are directly along the Gulf Coast. These counties/parishes are particularly vulnerable to the effects of OCS activities. As can be seen in **Table 4-23**, there are over 566,000 recreation jobs in the Florida, Alabama, Mississippi, and Louisiana coastal EIA counties/parishes. Over 400,000 of these jobs are in Florida, whose economy is particularly dependent on coastal recreation. Panel C of **Table 4-23** presents data on the total number of jobs in the recreation and tourism industries in each state; this data is primarily presented in order to provide some perspective on the relative size of the coastal recreational economies in these states. **Table 4-24** presents data on total wages earned in the leisure/hospitality industry for the same geographic regions discussed in **Table 4-23**. In 2009, workers in the leisure and hospitality industries in the Florida, Alabama, Mississippi, and Louisiana EIA's earned approximately $14 billion. The trends for each EIA over time are similar as was seen in **Table 4-23**. The effect on wages in 2005 in LA-4 and MS-1 from Hurricanes Katrina and Rita would appear to be less than that was observed for employment; however, this is simply a data issue since wages in 2005 include wages earned before the onset of Hurricanes Katrina and Rita in August and September 2005. It is worth noting that higher than average wages in LA-4, MS-1, FL-3, and FL-4 lead total wages in these areas to represent a greater fraction of total wages than these areas have in total employment (the average salary of workers can be closely approximated by dividing total wages by total employment in any geographic region). Similarly, wages were lower than average in LA-2, LA-3, AL-1, and FL-2.

Table 4-25 presents data on total tourism spending in each of the Gulf States (U.S. Travel Association, 2011). This is a somewhat different perspective than the wage data of **Table 4-24**. Total spending is higher than total wages since only a fraction of tourism spending translates into wages. For example, a portion of spending will end up as profit to the owners of the enterprises. In addition, spending on some items, particularly manufactured goods, may translate into wages to workers that are not categorized as being in the leisure/hospitality industry. Thus, looking at total spending provides a broader measure of the impact of tourism on the economies of the Gulf States. However, it is important to note that the data in **Table 4-25** focus only on spending by visitors and ignores spending on recreational activity by local residents. Therefore, the total economic impact of the recreation/tourism industry is somewhat greater than the data show.

Table 4-25 shows that visitors to the Gulf Coast States of Florida, Alabama, Mississippi, and Louisiana spent approximately $94 billion in 2008. The trends observed for spending are reasonably similar as was observed for wages. As seen in **Table 4-25**, there has been a gradual increase in tourism spending in most years in these states. We see the decline in spending in Louisiana and Mississippi associated with Hurricanes Katrina and Rita; however, 2006 was the first full year after the hurricanes and, thus, more fully reflects their impacts on tourism in these states. Tourism spending in these four states fell to $86 billion in 2009, which was likely primarily due to the severe recession that was occurring during that year.

A final perspective from which to view aggregate employment data is provided by Kaplan and Whitman (2008). This paper attempts to isolate those jobs that are particularly sensitive to OCS activities. For example, ocean and beach recreational activities are likely to be quite sensitive to OCS activities, particularly in the event of an oil spill. This is particularly true for some of the island-based recreational activities in the Gulf of Mexico; examples of these are Dauphin Island (Alabama) and the Gulf Islands National Seashore (Mississippi/Florida). However, a large portion of the jobs listed in **Table 4-23** occur in restaurants, gambling facilities, and a myriad of other types of recreational activities. While these types of activities can still be affected by OCS activities, these effects are less direct than for ocean-based tourism/recreation. Kaplan and Whitman (2008) attempt to account for this effect by weighting each recreational activity by the extent to which it applies to tourism activity, as well as the extent to which it is dependent on coastal resources.

Table 4-26 presents the estimated payroll, number of employees, and number of establishments associated with coastal travel, tourism, and recreation in 2004; there has not been a more recent study that uses an approach similar to Kaplan and Whitman. Kaplan and Whitman (2008) identify approximately 49,000 jobs in this category in Florida, Alabama, Mississippi, and Louisiana that support a payroll of approximately $1.1 billion. Approximately half of these jobs occur in Florida. There is a fair amount of uncertainty in these numbers due to measurement issues and to events that have occurred since the measurement period, most notably hurricanes and the DWH event and resulting oil spill. However, it is still of use to provide a rough estimate of the most at risk jobs in a particular area since this can give a sense of the scale of the broader effects OCS activities can have on activities that indirectly depend on these workers. Indeed, one of the particularly important contributions of this study is to estimate the number of coastal travel, recreation, and tourism jobs on a county-by-county basis, which can guide policymakers when analyzing the effects of the DWH event and of future potential accidental events.

Another manner in which OCS activity can affect recreation is through the effects of oil and gas structures themselves. Namely, there is a substantial amount of recreational fishing and recreational diving activity associated with these structures in the Gulf of Mexico. Hiett and Milon (2002) estimated that roughly 22 percent of all fishing trips in the Gulf of Mexico were taken within 300 ft (91 m) of an oil or gas structure during 1999. The study also found that approximately 94 percent of recreational diving trips took place near an oil or gas structure. The study also estimated that these trips led to $13.2 million in diving expenditures and $159.7 million in recreational fishing expenditures. More information on the structure of the recreational fishing industry in the Gulf of Mexico can be found in **Chapter 4.2.1.20.1**.

Recreational Resources in Florida, Alabama, Mississippi, and Louisiana

The Gulf Coast is host to a diverse range of recreational resources. For example, the beaches along the Gulf Coast support a number of recreational activities. **Table 4-29** presents the number of beaches and the number of visitors to these beaches in each Gulf Coast State. A detailed list of these beaches can be found in USEPA (2008c); a map of the location of each of these beach areas can be accessed using USEPA's online beach mapping tool (USEPA, 2011g). There are also a number of national parks, wildlife refuges, and marine sanctuaries that support recreational activities. An overall map of these Marine Protected Areas (MPA's) can be accessed at the National Marine Protected Areas Center's website (National Marine Protected Areas Center, 2010). More detailed information regarding each area, as well as a precise map of each MPA, can be accessed using the online mapping application provided by the National Marine Protected Areas Center (National Marine Protected Areas Center, 2011). The National Oceanic and Atmospheric Administration's ERMA mapping system also provides geographic data for each MPA; ERMA also provides information regarding the extent of the impacts of the DWH event on these sites (USDOC, NOAA, 2010o). Kaplan and Whitman (2008) provides information regarding the economic scale of some of these sites. A discussion of the individual sites in each state, as well as the dependence of the economies of each state on these resources, is presented below.

Florida has the largest coastal recreation economy among the Gulf Coast States. Approximately 80.9 million visitors to Florida in 2009 spent approximately $64 billion statewide (Visit Florida Research, 2011; U.S. Travel Association, 2011). One of the primary recreational activities near Florida's Gulf Coast is beach visitation, particularly in the northern Panhandle and in the southern half of the state. As can be seen in **Table 4-29**, USEPA reports 634 beaches in the 22 coastal counties along the Gulf of Mexico. The National Survey on Recreation and the Environment estimates that 22 million people from throughout the United States visit Florida beaches annually; the surveys that form the basis of this estimate were taken from 2005 through 2009. Alpert et al. (2008) estimate that there were 20 million out-of-state visitors and 2.2 million in-state visitors to Florida beaches in 2006. They estimate that beach tourism contributed $24.1 billion to Florida's economy in 2006 and supported approximately 275,000 jobs. Alpert et al. (2005) present a more detailed analysis of the economic impacts of beach tourism in Florida; they also provide information regarding the economic impacts of each beach region in Florida. For example, they estimate that beach visitors in the northwest and southwest beach regions in Florida spent $15.5 billion in 2002.

Florida is also the most economically significant state nationwide in a number of other coastal-related recreation activities. Florida has the largest recreational fishing industry in the United States, with approximately 160 million fish landed in 2009 (USDOC, NMFS, 2011e). Additional information on the structure of the recreational fishing industry in Florida and in the other Gulf Coast States can be found in **Chapter 4.2.1.20.1**. The recreational marine industry as a whole generated approximately $18.4 billion in spending and directly or indirectly supported 220,000 jobs in the region; this includes activities such as boating, marinas, fishing, and marine science research (Monterey Bay Aquarium Research Institute, 2008). Finally, the Florida system of State parks provided a direct economic impact of over $900 million (Monterey Bay Aquarium Research Institute, 2008); examples of these include the Gulf Islands National Seashore, St. George Island State Park, the De Soto National Memorial, Big Cypress National Preserve, Apalachicola National Forest, and Everglades National Park. There are also national wildlife refuges along Florida's coast that are used for various recreational activities; examples of these include Aucilla

Wildlife Management Area, Cecil M. Webb State Wildlife Management Area, and Steinhatchee Conservation Area.

Tourism and recreation accounted for $7.2 billion in tourism spending and 160,000 jobs in Alabama in 2009. Approximately 35 percent of spending and 36 percent of recreational employment in Alabama occurs along the Gulf Coast (Alabama Tourism Department, 2010). Mobile County has around 15,000 recreation workers, while Baldwin County has an additional 9,000 workers (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010a). Approximately 21 million people visited the State of Alabama as a whole (Alabama Tourism Department, 2010). The coastal areas are particularly dependent on beach recreation and wildlife activities (such as birding). For example, approximately 1 million people participated in wildlife viewing in Alabama in 2006 (USDOI, FWS and USDOC, Census Bureau,, 2006). Much of this activity occurs in State parks and refuges; examples of these include Maeher State Park, Gulf State Park, and the Marine Resources Division Laboratory on Dauphin Island.

Visitors to Mississippi spent approximately $5.9 billion in 2009, which helped to support 125,000 leisure/hospitality jobs statewide. Approximately $1.8 billion of this spending and 27,000 of these jobs occur in the Gulf Coast region (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010a; Mississippi Development Authority, 2010). Harrison County has the highest tourism employment in the region, with approximately 19,000 jobs. One of the primary contributors to the Gulf Coast recreation industry in Mississippi is the casino gaming industry that accounts for approximately 35 percent of recreational employment in the State (Mississippi Development Authority, 2010). Mississippi had 30 State-licensed casinos as of June 30, 2009; these casinos had revenues of $2.6 billion in 2009. Nine of these casinos are located along the Gulf of Mexico and had revenues of approximately $1.2 billion in 2009. In addition, the Mississippi District of the Gulf Islands National Seashore is an important recreational area; more information on the Gulf Islands National Seashore can be found through the National Parks Service (USDOI, NPS, 2010b).

The leisure hospitality industry in Louisiana brought in $8.9 billion in spending and supported 190,000 jobs Statewide in 2009. The EIA parishes with over 10,000 recreation workers are Calcasieu, Lafayette, East Baton Rouge, Jefferson, and Orleans (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010a). Jefferson and Orleans Parishes are the largest coastal recreation centers, with much of the tourism activity being driven by the various attractions of the New Orleans area. The recreation activity in these two parishes has been in a state of flux in recent years as they have attempted to recover from Hurricanes Katrina and Rita. For example, recreation employment in Orleans Parish fell from 43,508 in December 2004 to 18,064 in December 2005; it recovered to a level of 31,449 in December 2009 (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010a). The recreational activity in the remaining coastal counties in Louisiana centers around Cajun culture, wetlands, and wildlife activities. State parks in the coastal zone of Louisiana include Cypremort Point State Park, Palmetto Island State Park, Grand Isle State Park, St. Bernard State Park, and Fontainebleau State Park; a map of these parks can be found at (Louisiana Dept. of Culture, Recreation, and Tourism, 2010). Coastal Louisiana is also characterized by a vast array of wildlife refuges that support a variety of recreational activities; those that are closest to the Gulf of Mexico include Sabine National Wildlife Refuge, Rockefeller State Wildlife Refuge and Game Preserve, Russell Sage Foundation Marsh Island State Wildlife Refuge, Atchafalaya Delta State Wildlife Management Area, Pointe Aux Chenes Wildlife Management Area, Delta National Wildlife Refuge, Pass a Loutre State Wildlife Management Area, Biloxi State Wildlife Management Area, Breton National Wildlife Refuge, and Bayou Savage National Wildlife Refuge.

Change in Baseline Conditions due to the *Deepwater Horizon* Event

The previous discussion presents the tourism/recreation baseline prior to the DWH event and resulting oil spill. This oil spill was a major event that affected the recreation industry in a number of ways. The most direct effects of the spill were on recreational fishing and on beach visitation. For example, at the height of its impact, the spill had closed 36.6 percent of recreational fishing areas in the Gulf of Mexico (this occurred on June 2); as of April 19, 2011, all Federal waters have been reopened to fishing activity (USDOC, NOAA, 2011i). **Chapter 4.2.1.20** contains more information on the impacts of the oil spill on recreational fishing activity. In addition, several beaches between eastern Louisiana and the northeast corner of Florida have experienced either advisories or closures due to the spill (a list of these advisories/closures can be found at National Resources Defense Council, 2010). The National Oceanic and Atmospheric Administration's ERMA mapping system provides a graphic representation of the status of shoreline cleanup operations on Gulf Coast beaches. This site categorizes shorelines into the following categories: (1) work required; (2) work in progress; (3) cleaned to Shoreline Treatment Recommendation levels; and (4) verified to be clean. As of January 11, 2011, a fair amount of progress has been made towards cleaning affected shorelines. However, areas such as Bon Secour (Alabama), Gulf Islands National Seashore (Florida), and Barataria Bay (Louisiana) still had a number of areas in which cleanup work is still in progress. The OSAT-2 report (2011) provides a more detailed analysis of the status of cleanup operations in four areas of particular interest: Grand Isle (Louisiana), Petit Bois Island (Mississippi), Bon Secour (Alabama), and Fort Pickens (Florida).

The damage to the aforementioned recreational resources caused a number of immediate impacts to the economies in the Gulf of Mexico. A decrease in tourism to affected areas caused a number of impacts to hotels and other firms in certain areas. A broad summary of the impacts to tourism felt along the Gulf Coast is presented in *The BP Oil Spill and the Gulf Coast Tourism: Assessing the Impact* (U.S. House of Representatives, 2010). This report documents that the effects of the spill on tourism activity were felt in areas beyond those with damage to physical recreational resources. *Press-Register* (2010) provides data on the change in hotel and sales tax receipts for individual Gulf Coast counties during the summer of 2010 compared with the summer of 2009; Propublica (2011) provides similar data for the 6 months following the DWH event. During the summer of 2010, the spill caused substantial declines in hotel receipts in the following counties: Baldwin, Alabama (33.2% decline); Santa Rosa, Florida (24.8% decline); Okaloosa, Florida (24.1% decline); Walton, Florida (12.3% decline); and Bay, Florida (7.4% decline). However, coastal counties west of Baldwin, Alabama, generally experienced noticeable increases in hotel receipts. This was particularly true in Mobile, Alabama; Jackson, Mississippi; and in the coastal parishes of Louisiana. For example, in Louisiana, St. Mary, Terrebonne, and Lafourche Parishes each reported increases in hotel tax receipts of over 80 percent in the summer of 2010. These effects are likely due to the influx of oil-spill relief workers to these areas in the immediate aftermath of the spill. Overall sales tax receipts in counties from Baldwin, Alabama, eastward also generally fell during 2010, although to a lesser extent than hotel tax receipts. Sales tax receipts in counties west of Baldwin, Alabama, did not show as clear a pattern as did hotel tax receipts. For example, overall sales tax receipts fell by 12.5 percent in Hancock County (Mississippi), receipts were almost unchanged in Harrison County (Mississippi), and receipts increased by 8.3 percent in Orleans Parish (Louisiana). The 6-month data provided by Propublica (2011) suggests that the negative effects of the spill on tourism moderated to some extent towards the end of 2010. For example, in Florida, combined sales and hotel tax receipts during the 6 months following the spill ranged from a fall of 5 percent in Walton County to an increase of 4 percent in Jefferson County.

Data on damage claims through the Gulf Coast Claims Facility provide measures of the extent of the damage from the spill to date. **Tables 4-73 through 4-76** provide data on the number of claims and the amount of claims paid to individuals and firms in each Gulf Coast State. Through May 16, 2011, Florida has had the largest level of damage claims ($1.6 billion), followed by Louisiana ($1.3 billion), Alabama ($750 million), and Mississippi ($350 million). The bulk of the total dollar value of claims in these four states have occurred in the retail, sales, and service industry ($1.4 billion); the food, beverage, and lodging industry ($1.2 billion); the fishing industry ($646 million); and the rental property industry ($469 million). Direct losses in the recreation industry were $88 million, although the losses in the other industries were tourism-related.

Data on employment and wages provide another perspective from which to view the impacts of the oil spill on recreation and tourism along the Gulf Coast. **Table 4-31** presents monthly data on total employment in the leisure/hospitality industry during 2010. These data are presented for the same geographic regions as in **Table 4-23**; all employment and wage data were obtained through the U.S. Dept. of Labor, Bureau of Labor Statistics. The definition of the leisure/hospitality industry corresponds to the definition used by the North American Industrial Classification System; this definition includes sub-industries such as entertainment providers, lodging services, and food/beverage services. In **Table 4-31**, we can see that overall employment in the leisure/hospitality industry did not noticeably fall during the months following the DWH event in any geographic region. Indeed, employment in most regions was strikingly stable. The only region with a notable fall in employment was FL-4, although this fall was likely partially seasonally related. **Table 4-32** presents quarterly data on total wages earned by workers during 2009 and 2010 in the leisure hospitality industry for the same geographic regions as were presented in **Table 4-31**. Wages generally exhibited the stability seen in overall employment. Indeed, the only EIA that exhibited a fall in wages from the third quarter of 2009 to the third quarter of 2010 was

FL-1, which experienced a decline in wages of 2.3 percent. This overall stability exhibited in recreational employment is likely due to the effects of the spill relief workers and the damage payments received by the affected parties. While this overall stability in employment surely masks some variation in particular industries and regions, it does suggest that, as of yet, the oil spill has not drastically changed the structure of the recreation industry in the Gulf Coast.

For the purposes of discussing the baseline environment, there is an important distinction between those effects that occurred during the spill versus those that will persist in the aftermath of the spill. Although some cleanup operations are ongoing in some areas, the majority of the oil has been removed from the recreational resources along the Gulf Coast. However, the speed at which tourism activity will return to the Gulf Coast remains unclear. Oxford Economics (2010) conducted a study of recent catastrophic events in order to estimate the longer-term economic implications of the DWH event and resulting oil spill. Analyzing previous oil spills and other catastrophic events, they suggest that it could take 15-36 months for the tourism industry to recover to pre-spill levels. Anecdotal evidence suggests that tourism activity is indeed gradually recovering from the spill; for example, see Nelson (2011), National Public Radio (2011), and Stacy (2011). However, it will take some time to more accurately gauge the speed at which tourism activity is returning to pre-spill levels. The BOEM will continue to monitor this issue and will update its assessment of baseline conditions for recreational resources as new information becomes available.

While there remains some uncertainty regarding the impacts of the DWH event on recreational resources, and this incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts, BOEM does not believe that this incomplete information is essential to a reasoned choice among alternatives. Even after the DWH event, the types of impacts to recreational resources were largely foreseeable (e.g. reductions in local tourism, reduced angler trips, a shifting of recreational activities to nearby areas), but recent data indicate that most of these impacts were generally short term or are continuing to improve. While there remains some uncertainty as to the geographical scope of these impacts based on the size and timing of the spill and to the impact of public perception in the short and long term, BOEM has taken these concerns into account in its analysis in this EIS.

4.2.1.21.2. Impacts of Routine Events

Background/Introduction

Routine OCS oil and gas activities can affect recreation and tourism in diverse ways. The OCS activities can have direct negative impacts on beach and coastal recreational resources through discharges of marine debris, noise, and visual impairments. There are also possible indirect impacts on local recreational resources from space-use conflicts and from increased economic activity from OCS operations. The unique role that oil platforms can play as artificial reefs should also be accounted for when considering policy actions. Finally, the possible effects of public perceptions on tourism, particularly in light of the DWH event, should be considered. However, while impacts on recreational resources from routine OCS activities can occur from a number of sources, in total they are likely to be reasonably small in scale.

Beaches and other coastal recreational resources are the most vulnerable to routine OCS operations. One concern is the extent to which discharges of marine debris from OCS actions could reach these areas. Debris can noticeably affect the aesthetic value of coastal areas, particularly beaches. This is particularly true given the significant levels of marine debris that already exist in some areas. Marine debris originates from OCS operations, sewage treatment plants, recreational and commercial fishing, industrial manufacturing, and various forms of vessel traffic. Adler et al. (2009) present a broad overview of the nature of the marine debris problem. Various government agencies participate in a coordinated effort to combat marine debris; a broad summary of the issues involved and the policy structure with respect to marine debris can be found in the report of the Interagency Marine Debris Coordinating Committee (USDOC, NOAA, 2008b). There is also a national monitoring program in place to track the progression of the marine debris problem in various locations. Ocean Conservancy (2007) describes the structure of the National Marine Debris Monitoring Program; Ocean Conservancy (2011) presents the results from the most recent round of debris monitoring. This study found that Florida had the most debris in the Gulf of Mexico (606,766 pieces of debris were collected); this was followed by Texas (188,364), Alabama (68,585), Mississippi (47,746), and Louisiana (21,751). McIlgorm et al. (2009) present an economic analysis of the costs of marine debris and of programs designed to minimize debris. This study describes that marine debris has a particular impact on fishing activity, the shipping industry, tourism activity, and on activities related to marine ecosystems. Finally, Barnea et al. (2009) outlines some issues regarding debris removal that are unique to the Gulf of Mexico.

The discharge of marine debris is subject to a number of laws and treaties. These include the Marine Debris Research, Prevention, and Reduction Act; the Marine Plastic Pollution Research and Control Act; and the MARPOL-Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. The BSEE policy regarding marine debris prevention is outlined in NTL 2012-BSEE-G01. This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harms of discharging marine debris. This NTL also states that OCS workers should complete annual marine debris prevention training; operators are also instructed to develop a certification process for the completion of this training by their workers. These various laws, regulations, and NTL's will likely minimize the potential damage to recreational resources from the discharge of marine debris from OCS operations.

There are also potential negative impacts on beach tourism from vessel noise and from the visibility of OCS infrastructure. While the potential effects of noise on tourism are difficult to quantify, several characteristics of the OCS industry serve to minimize these effects. First, most OCS-related vessel traffic moves between onshore support bases and production areas far offshore. Support bases are located in industrial ports, which are usually distant from recreational use areas. Second, OCS vessel use of approved travel lanes should keep noise fairly transitory and thus unlikely to noticeably impact tourism. The extent to which the visibility of OCS platforms can affect tourism depends primarily on the distance of platforms from shore and on the size of the particular platform. For example, a study by the Mississippi Development Authority found that a 50-ft (15-m) high production platform was identifiable 3 mi (5 km) from shore and a 100-ft (30-m) high production platform was visible 10 mi (16 km) from shore (Collins Center for Public Policy, 2010). All OCS platforms are at least 3 mi (5 km) from shore and most are beyond 10 mi (16 km) from shore. Even if a platform was visible, the scale of its impact on tourism would likely be small unless it interrupted the vision of other important landscape features.

Oil platforms serve unique roles as artificial reefs. Soon after deployment, an oil platform attracts a wide variety of fish species and other organisms to its structure. As a result, some offshore platforms are important components to the recreational fishing industry; oil platforms are also hosts to a large amount of recreational diving activity (Hiett and Milon, 2002). The role of oil rigs as artificial reefs also raises a number of issues during the decommissioning stage of an oil platform's life. Each Gulf Coast State has a mechanism for allowing some oil platforms to remain in place to serve as artificial reefs after oil production has ceased; Dauterive (2000) provides an overview of these programs. McGinnis et al. (2001) also discusses the broader economic implications of decommissioning oil structures. This decommissioning stage has the potential to affect recreational resources in a particular area if a rig is ultimately not maintained for reef purposes or if the rig is moved to a different location. More information regarding the effects of OCS platforms on recreational fishing activity can be found in **Chapter 4.2.1.20.2**.

The OCS oil and gas activity can also affect recreational resources indirectly due to a number of economic factors. First, increased onshore infrastructure necessary to support offshore activities can create space-use conflicts. For example, Brody et al. (2006) present an analysis of space-use conflicts for oil and gas activities off the coast of Texas, although the issues they raise would be generally applicable to OCS activities in the other Gulf Coast States as well. They used a GIS-based framework to identify specific locations where conflicts between oil activities and other concerns (including recreational use) are most acute; they found that recreational use conflicts tend to be concentrated around some of the major wildlife viewing and beach areas near the larger population areas in Texas. In the CPA, the potential for space-use conflicts would be greatest along coastal Louisiana, particularly near Port Fourchon (Lafourche Parish). **Chapter 4.2.1.23.1** provides more detailed information regarding the ports and other facilities that support OCS activities in the CPA. The vessel traffic near these facilities could cause space-use conflicts with boating and recreational fishing activities. However, even if a space-use conflict was to arise in a particular instance, it is likely that a number of substitute recreational sites would be available. In addition, given the entrenched nature of the OCS oil and gas industry in coastal Louisiana, it is unlikely that any particular OCS action would significantly add to space-use conflicts in this area.

The OCS activities also have the potential to increase or decrease the demand for recreational resources in certain communities. Increased demand for recreational resources has the potential to attract new recreational firms to a community; however, increased demand also has the potential to lessen the enjoyment of a particular resource by some community members. Mason (2010) provides some context on the interdependence of the offshore oil and gas industry with other sectors of the economy of the Gulf of Mexico; for example, they show that accommodation and food service resources have a reasonably high dependence on OCS activities. Wallace et al. (2001) also discuss community level effects of OCS activities on some of the local economies in the Gulf of Mexico; for example, this study presents descriptive evidence regarding concerns some local residents have regarding the impacts of OCS activities on recreational opportunities. However, given the limited scale of a CPA proposed action relative to the existing oil and gas industry, the scale of the indirect economic impacts caused by new leasing activity is likely to be small.

While the DWH event primarily affected the baseline environment and our understanding of the impacts of accidental events, it also raises issues regarding the effects of OCS routine actions on recreation and tourism. Because of the particular sensitivity of tourism activity to public perceptions, concerns over offshore oil operations could potentially cause routine OCS actions to have impacts even in the absence of a future spill. This is particularly the case for recreational resources that require investments in real estate or other long-term fixed assets. For example, CoreLogic (2010) forecasted a loss of up to $3 billion in the 15 most affected coastal counties over 5 years due to the DWH oil spill. However, since the DWH event resulted in less severe impacts on beaches than CoreLogic (2010) used in its estimates, the DWH event's impacts on property values may be less than CoreLogic (2010) initially forecasted. As such, BOEM believes the CoreLogic estimate likely remains conservative for purposes of this EIS. It is possible that some of these effects would be magnified if additional OCS activity added to fears of another oil spill. However, given that a CPA proposed action does not substantially change the structure of OCS operations in the Gulf of Mexico, this effect is likely to be relatively small.

Proposed Action Analysis

A CPA proposed action would result in 81-156 producing oil wells, 108-241 producing gas wells, and 35-67 installed production platforms (**Table 3-3**). Marine debris would occasionally be discharged due to OCS operations associated with drilling activities projected to result from a CPA proposed action. However, the various laws, regulations, and NTL's related to the discharge of marine debris are expected to keep these discharges to a low level. A CPA proposed action is expected to result in 94,000-168,000 service-vessel trips and 696,000-1,815,000 helicopter operations. Service vessels are assumed to use established nearshore traffic lanes, and helicopters will usually comply with areal clearance restrictions. These actions tend to distance traffic from major recreational areas. The additional helicopter and vessel traffic would add a low level of noise pollution that would affect beach users.

Summary and Conclusion

Routine OCS actions in the CPA can cause minor disturbances to recreational resources, particularly beaches, through increased levels of noise, debris, and rig visibility. The OCS activities can also change the composition of local economies through changes in employment, land use, and recreation demand. A CPA proposed action has the potential to directly and indirectly impact recreational resources along the Gulf coast. However, the small scale of a CPA proposed action relative to the scale of the existing oil and gas industry suggests that these potential impacts on recreational resources are likely to be minimal.

4.2.1.21.3. Impacts of Accidental Events

Background/Introduction

The recreational resources most vulnerable to an oil spill are the beaches and nature parks along the Gulf Coast. Environmental Sensitivity Indexes (ESI's) provide overall measures of the sensitivity of a particular coastline to a potential oil spill (USDOC, NOAA, 2010p). The ESI's rank coastlines from 1 (least sensitive) to 10 (most sensitive). Marshes and swamps are examples of resources that have ESI's of 10 due to the extreme difficulty of removing oil from these areas. The ESI's for beach areas generally range from 3 to 6, depending on the type of sand and the extent to which gravel is mixed into the beach area. The ESI maps for any coastline along the Gulf of Mexico can be viewed using the National Oceanic and Atmospheric Administration's ERMA mapping system (USDOC, NOAA, 2010o). The ESI maps also provide point indicators for recreational resources. A more detailed map of the nature parks and wildlife refuges in the Gulf of Mexico can be found at the National Marine Protected Area Center (National Marine Protected Area Center, 2010). More information on any particular park can be found using the online, interactive mapping application provided by the National Marine Protected Area Center (National Marine Protected Area Center, 2011).

The effects of an oil spill on a particular beach region will depend on the success of the containment and cleanup operations following an oil spill. The NOAA provides a broad overview of the procedures used to clean oiled beaches (USDOC, NOAA, 2000). Both manual and machine-based techniques can be used to clean oil; the cleaning technique chosen for a particular beach will depend on the nature of the oiling of a particular beach area. The nature of cleanup operations will also depend on whether a particular beach serves as a habitat to particular animal species because removing oil deep below a beach surface can sometimes do more ecological harm than good. As a result, ecological beaches are often only cleaned to a shallow depth, while nonecological ("amenity") beaches are often cleaned more extensively. The same is true around cultural and archaeological sites, such as shipwrecks embedded in the beach, where manual cleaning techniques may be dictated. The cleanup plan for any particular beach is determined by a Shoreline Treatment Recommendation, which is prepared by the relevant State and Federal agencies for a particular spill. An example of a Shoreline Treatment Recommendation following the DWH event for Grande Isle, Louisiana can be found at RestoreTheGulf.gov (2010c). The OSAT-2 report (2011) provides an analysis of the status of cleanup operations from the DWH event in four areas of particular interest: Grand Isle (Louisiana); Petit Bois Island (Mississippi); Bon Secour (Alabama); and Fort Pickens (Florida). This report categorizes the status of cleanup operations at certain segments of these locations (as of January 12, 2011) into the following categories: (1) work required; (2) work in progress; (3) cleaned to Shoreline Treatment Recommendation levels; and (4) verified to be clean. While a number of these areas were categorized as having been cleaned, there were still ongoing cleanup operations at certain segments of all of these locations. Wang and Roberts (2010) present an analysis of field examinations of beach areas following the DWH oil spill. This study found a number of beach areas in which oil remained buried under the surface, and it also points out that beach cleaning techniques can leave remnant oil on beach surfaces. Wang and Roberts (2010) found examples of beaches where less than 25 percent of overall oil contamination had been removed. However, since this study was based on samples of certain beach segments, the study does not attempt to quantify the level of oil contamination in broad beach regions.

Recreational resources such as beaches serve as important bases for certain local economies. Therefore, oiled beach regions can cause economic losses to both individuals and firms in the area of an oiled or closed beach. Parsons and Kang (2007) perform an economic analysis of the costs of hypothetical beach closures along the Texas Gulf Coast. They estimate that the economic costs of beach closures along the Padre Island National Seashore would range from $26,000 to $172,000 per day, depending on the time of year at which the closures would occur. The oil spill off the Tampa Bay, Florida, coast in 1993 is an example of a spill that affected recreational beaches. Damage to these beaches and other recreational resources was determined to cause $2.5 million in damages to the affected parties in the area (Florida Dept. of Environmental Protection and USDOC, NOAA, 2000). Finally, the New Orleans oil spill of 2008 demonstrates that a spill can affect different types of recreational activities. Namely, this spill impacted some of the boating and restaurant businesses in its vicinity; it also caused some aesthetic impacts to the experiences of tourists in the region (Tuler et al., 2010).

The DWH event was much larger than the previously mentioned spills. As such, it raises important questions regarding the impacts of oil spills on recreation and tourism. One important point is that a spill of the DWH event's dimensions can influence a much broader range of individuals and firms than can a smaller spill. For example, a small, localized spill may lead some travelers to seek substitute recreational opportunities in nearby areas. However, a large spill is more likely to dissuade travelers from visiting a broader economic region. Similarly, small- and mid-sized restaurant chains and hotels may be able to find other customers or to simply weather a smaller spill. However, a spill the size of the DWH event is more likely to affect these types of firms since they are less able to diversify their customer base. These effects can be seen in the makeup of those who have filed damage claims with BP (Gulf Coast Claims Facility, 2012). For example, the bulk of the claims by individuals have been made in the food, beverage, and lodging sector and in the retail, sales, and service sector. Claims have also been made by individuals and firms in a broad range of geographic regions, many of which were not directly impacted by oil

The claims process and the cleanup process must also be taken into account when attempting to ascertain the ultimate impacts of a spill on a recreational economy. For example, one analysis found a noticeable increase in hotel receipts in coastal Louisiana and on the Mississippi/Alabama border during the summer of 2010 compared with the summer of 2009; this same study found that counties in the northwest corner of Florida experienced a noticeable decrease in receipts during the same time periods (*Press-Register*, 2010). While the spill caused economic damage to a number of people in the Louisiana and Mississippi/Alabama border area, this example demonstrates that the effects of cleanup and damage mitigation activities must be taken into account when analyzing the overall impact of a spill on recreational economies.

The broad impact of the DWH event also highlights the critical role of media coverage and public perceptions in determining the extent to which an oil spill will affect the recreational economy. Namely, there were a number of reports that various effects on tourism were felt in areas beyond the locations in which oil washed up along beaches and other areas. A Congressional hearing into this matter (U.S. House of Representatives, 2010) provides a broad overview of some of the effects that were felt along the Gulf Coast. For example, a representative of Pinellas County estimated that this area had lost roughly $70 million in hotel revenue even though beaches in this area did not receive any oil damage. This type of effect could be due to misperceptions about the spill, uncertainty about the future of the spill, or concerns about whether a tourism experience will be affected even if the destination is only within close proximity to a spill. For example, CoreLogic (2010) forecasted a loss of up to $3 billion in the 15 most affected coastal counties over 5 years due to the DWH oil spill; however, since the DWH event turned out to have less severe impacts on beaches than CoreLogic (2010) used in its estimates, the DWH's impacts on property values may be less than CoreLogic (2010) initially forecasted. It is possible that some of these effects would be magnified if additional OCS activity added to fears of another oil spill. While these effects are complex and largely determined by the dynamics of a particular spill, the DWH event demonstrates that they must be considered as part of the full effects of a spill.

Oxford Economics (2010) attempts to quantify these effects by analyzing the impacts of recent catastrophic events on recreational economies. For example, they analyzed the *Ixtoc* oil spill of 1979, the scale and nature of which is reasonably similar to the DWH event. In this example, it took approximately 3 years for beaches to be cleaned and for recreational activity to return to similar levels as before the spill. They also looked at the *Prestige* oil spill of 2002 off the coast of Spain. Given the nature and size of that spill, recreational activity was able to return to pre-spill levels in approximately 1 year. Alaska's tourism economy took approximately 2 years to recover from the *Exxon Valdez* spill. Having analyzed those spills and other accidental events, Oxford Economics (2010) forecasted that it would take 15-36 months for certain recreational economies along the Gulf Coast to recover from the DWH event. However, given that the tourism economies of the Gulf Coast have largely already recovered from the spill, it seems as though the actual time needed to recover from the DWH event was on the low end of the estimates of Oxford Economics (2010); more information on the impacts of the DWH event on baseline conditions for recreational resources can be found in **Chapters 4.1.1.18.1 and 4.2.1.21.1**.

Proposed Action Analysis

Figure 3-26 displays the probabilities of oil spills ≥1,000 bbl occurring and contacting certain beach areas as a result of a CPA proposed action. The beach areas with a 1 percent chance or greater of being contacted by an oil spill are (the 10-day and 30-day probabilities are both presented, respectively): The Texas Coastal Bend beach area (<0.5% and 1-2%); the Matagorda beach area (<0.5 and 2-4%); the Galveston beach area (1-2% and 3-6%); the Texas Sea Rim State Park beach area (<0.5-1% and 1-2%); and the Louisiana beach area (3-6% and 5-10%). The ESI maps of the Texas and Louisiana coastlines can be found using the National Oceanic and Atmospheric Administration's ERMA mapping system (USDOC, NOAA, 2010o). Much of the Galveston Beach area is characterized by fine-grained sand beaches, while the Matagorda Beach area generally has coarser grained sand (which is somewhat more difficult to clean after an oil spill). Most portions of the beach region in western Louisiana have an ESI rating of 3, suggesting that a small-scale spill would be able to be cleaned in a reasonable period of time. However, the vast majority of the nature preserves along the remainder of coastal Louisiana are characterized by marsh and swamp areas, which have an ESI of 10. Oil entering these recreational areas would take a fair amount of time and effort to clean. This would have a particular impact on recreational fishing activity; more information regarding recreational fishing can be found in **Chapter 4.2.1.20**. However, given that recreational uses of these areas are less densely concentrated, it would take a large-sized spill to alter the structure of the recreational industry in a particular region. **Figures 3-27 and 3-28** present the probabilities of an oil spill from a CPA proposed action reaching certain recreational diving sites. The recreational diving areas with a >1 percent chance of being contacted by an oil spill are (the 10-day and 30-day probabilities are both presented, respectively): Port Lavaca Liberty Ship reef (1-2% and 3-5%); High Island (1-2% and 2-5%); West Cameron (2-4% and 4-8%); Vermillion Area (3-6% and 5-10%); Vermillion Area, South Addition (3-5% and 4-8%); South Timbalier (5-9% and 6-11%); South Timbalier, South Addition (3-6% and 4-8%); and the Florida Panhandle area (<0.5% and 1-2%).

Summary and Conclusion

Spills most likely to result from a CPA proposed action would be small, of short duration, and not likely to impact Gulf Coast recreational resources. Should an oil spill occur and contact a beach area or other recreational resource, it would cause some disruption during the impact and cleanup phases of the spill. However, these effects are also likely to be small in scale and of short duration. In the unlikely event that a spill occurs that is sufficiently large to affect large areas of the coast and, through public perception, has effects that reach beyond the damaged area, the effects to recreation and tourism could be substantial, at least in the short term.

4.2.1.21.4. Cumulative Impacts

Background/Introduction

The cumulative impacts to recreational resources would occur through a CPA proposed action, the existing OCS Program, and from the expected impacts of external events and actions to recreational resources and tourism activity. A CPA proposed action would contribute to a number of aesthetic and space-use issues arising from existing oil and gas programs. The OCS activities can also impact the recreational uses of beaches and wetland areas, which are already being impacted through coastal erosion. Finally, lingering impacts of the DWH event would contribute to the incremental impacts of an oil spill, should one arise from a CPA proposed action.

Aesthetic Impacts

A CPA proposed action would contribute to some negative aesthetic impacts of the existing OCS Program and State oil and gas programs. First, oil and gas activities will contribute to the marine debris problems experienced by the Gulf Coast. Marine debris can noticeably affect the aesthetic value of coastal areas, particularly beaches. This is particularly true given the significant levels of marine debris that already exist in some areas. Marine debris originates from OCS operations, sewage treatment plants, recreational and commercial fishing, industrial manufacturing, and various forms of vessel traffic. Adler et al. (2009) present a broad overview of the nature of the marine debris problem. Various government agencies participate in a coordinated effort to combat marine debris; a broad summary of the issues involved and the policy structure with respect to marine debris can be found in the report of the Interagency Marine Debris Coordinating Committee (USDOC, NOAA, 2008b). There is also a national monitoring program in place to track the progression of the marine debris problem in various locations. Ocean Conservancy (2007) describes the structure of the National Marine Debris Monitoring Program; Ocean Conservancy (2011) presents the results from the most recent round of debris monitoring. This study found that Florida had the most debris in the Gulf of Mexico (606,766 pieces of debris were collected); this was followed by Texas (188,364), Alabama (68,585), Mississippi (47,746), and Louisiana (21,751). McIlgorm et al. (2009) present an economic analysis of the costs of marine debris and of programs designed to minimize debris. This study describes that marine debris has a particular impact on fishing activity, the shipping industry, tourism activity, and on activities related to marine ecosystems. Finally, Barnea et al. (2009) outline some issues regarding debris removal that are unique to the Gulf of Mexico.

The discharge of marine debris is subject to a number of laws and treaties. These include the Marine Debris Research, Prevention, and Reduction Act; the Marine Plastic Pollution Research and Control Act;

and the MARPOL-Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. The BSEE policy regarding marine debris prevention is outlined in NTL 2012-BSEE-G01. This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harms of discharging marine debris. This NTL also states that OCS workers should complete annual marine debris prevention training; operators are also instructed to develop a certification process for the completion of this training by their workers. These various laws, regulations, and NTL's will likely minimize the potential damage to recreational resources from the discharge of marine debris from OCS operations.

The oil platforms and infrastructure that arise from a CPA proposed action would contribute to the existing visibility of oil facilities along the Gulf Coast. The extent to which the visibility of OCS platforms can affect tourism depends primarily on the distance of platforms from shore and on the size of the particular oil rig. For example, a study by the Mississippi Development Authority found that a 50-ft (15-m) high production platform was identifiable 3 mi (5 km) from shore and a 100-ft (30-m) high production platform was visible 10 mi (16 km) from shore (Collins Center for Public Policy, 2010). All OCS platforms are at least 3 mi (5 km) from shore and most are beyond 10 mi (16 km) from shore. Even if a platform was visible, the scale of its impact on tourism would likely be small unless it interrupted the vision of other important landscape features.

There are also potential negative impacts on beach tourism from vessel noise and from the visibility of OCS infrastructure. While the potential effects of noise on tourism are difficult to quantify, several characteristics of the OCS industry serve to minimize these effects. First, most OCS-related vessel traffic moves between onshore support bases and production areas far offshore. Support bases are located in industrial ports, which are usually distant from recreational use areas. In addition, OCS vessel use of approved travel lanes should keep noise fairly transitory and, thus, are unlikely to noticeably impact tourism.

Space-Use Conflicts

A CPA proposed action would also contribute to space-use conflicts between recreational activities and the broader OCS Program. Brody et al. (2006) present an analysis of space-use conflicts for oil and gas activities off the coast of Texas, although the issues they raise are generally applicable to OCS activities. They use a GIS-based framework to identify specific locations where conflicts between oil activities and other concerns (including recreational use) are most acute; they find that recreational use conflicts tend to be concentrated around some of the major wildlife viewing and beach areas near the larger population areas in Texas. In the CPA, the potential for space-use conflicts would be greatest along coastal Louisiana, particularly near Port Fourchon (Lafourche Parish). **Chapter 4.2.1.23.1** provides more detailed information regarding the ports and other facilities that support OCS activities in the CPA. The vessel traffic near these facilities could cause space-use conflicts with boating and recreational fishing activities. However, even if a space-use conflict was to arise in a particular instance, it is likely that a number of substitute recreational sites would be available. In addition, given the entrenched nature of the OCS oil and gas industry in coastal Louisiana, it is unlikely that any particular OCS action would significantly add to space-use conflicts in this area.

Oil Spills

A CPA proposed action would contribute incrementally to the likelihood of an oil spill caused by the broader OCS Program. **Table 3-12** presents data on the number and size of oil spills that are expected to arise from a CPA proposed action. For example, it is estimated that a CPA proposed action would lead to <1 to 1 spill ≥1,000 bbl. However, oil spills could also arise from the OCS industry that is currently in place in the CPA. Thus, the impacts of accidental events on recreational resources, which are discussed in **Chapter 4.2.1.21.3**, should be viewed in light of the incremental increase in the likelihood of an oil spill that would be associated with a CPA proposed action.

Beach/Wetland Depletion

The OCS Program occurs in an environment in which beach and wetland resources are undergoing depletion due to human development, hurricanes, and natural processes. An overview of coastal erosion threats can be found in *Evaluation of Erosion Hazards* (The Heinz Center, 2000). Government policy towards managing beach erosion can be found at the website of NOAA's Coastal Services Center (USDOC, NOAA, 2011e). Routine OCS actions can contribute to coastal erosion through channel dredging, pipeline placements, and vessel traffic. Oil spills have the potential to contribute to beach erosion, both due to contaminated sentiment and to the potential sediment losses during the cleanup process. A more detailed discussion of the cumulative impacts of OCS actions on coastal beaches and dunes is presented in **Chapter 4.2.1.3.4**. Further information on the cumulative impacts of OCS activities on wetlands resources can be found in **Chapter 4.2.1.4.4**.

Deepwater Horizon *Event and Tourism*

The effects of the DWH event on tourism and recreational activity are still evolving. While a number of workers in the recreational industry were financially harmed, the response and mitigation activities have helped put the tourism industry in the affected areas on a path to recovery. However, the DWH event will help shape public reaction to any future spills or other accidental events that occur due to offshore leasing programs on the OCS or in State waters. For example, the role of perceptions will likely be magnified in any future spill due to the large amount of media attention given the DWH event. On the other hand, lessons learned from the DWH event may lessen the severity of a future spill; therefore, some effects on recreation may be lessened in the future. Lessons learned from the DWH event may also lower the probability of a future catastrophic oil spill. The cumulative impact of a CPA proposed action to these effects is small since the probability of another spill on the scale of the DWH event is quite low.

Summary and Conclusion

A CPA proposed action would contribute to the aesthetic impacts and the space-use conflicts that arise due to the broader OCS Program. Oil spills could also contribute to the overall degradation of beach and wetland-based recreational resources. The dynamics of any future oil spill will also be influenced by the damage done and lessons learned from the DWH event. However, the cumulative impacts of a CPA proposed action on recreational resources are small since the incremental increase in the probability of a large spill is also low. The incremental contribution of a CPA proposed action is expected to be minimal, in light of all non-OCS-related activities such as aesthetic impacts (including from other industrial sources), wetland loss, and space-use conflicts.

4.2.1.22. Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 250.105 and 550.105). The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in **Chapters 4.2.1.22**. A brief summary of potential impacts follows. Archaeological resources could be impacted by the placement of drilling rigs and production systems on the seafloor; pile driving associated with platform emplacement; pipeline placement; dredging of new channels, as well as maintenance dredging of existing channels; anchoring activities; pipeline installation; post-decommissioning trawling clearance; and the masking of archaeological resources from industry-related debris.

The BSEE and BOEM agree that, between the two agencies, BOEM should take the lead in ensuring that both agencies comply with Section 106 of the National Historic Preservation Act to, among other things, prevent redundancies in effort and avoid conflicts. The BOEM will have the required expertise and experience to evaluate the significance of archaeological resources and would provide guidance to BSEE on how to protect a newly discovered resource. The BOEM would inform BSEE of the reported discovery because BSEE, as the regulator, needs to know when to assure that operations are halted.

The impact of coastal and marine environmental degradation from OCS activities is expected to minimally affect cultural resources in comparison to other sources of coastal erosion and subsidence. Impacts of routine discharges are localized in time and space, are regulated by USEPA permits, and will have minimal impact. Accidental events that could impact archaeological resources include blowouts and oil or chemical spills and the associated cleanup response activities. Although information on the impacts of a potential spill to archaeological resources is incomplete or unavailable at this time and may be relevant to reasonably foreseeable adverse impacts on these resources, the information is not essential to a reasoned choice among alternatives. An oil spill occurring and contacting an archaeological resource is unlikely, given that oil released tends to rise quickly to the surface and that the average size of any spill would be small.

Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, are expected to be effective at identifying possible archaeological sites. Offshore oil and gas activities resulting from a CPA proposed action could impact an archaeological resource because of incomplete knowledge on the location of these sites in the Gulf. The risk of contact to archaeological resources is greater in instances where archaeological survey data are unavailable. Such an event could result in the disturbance or destruction of important archaeological information. Archaeological surveys, where required, would provide the necessary information to develop avoidance strategies that would reduce the potential for impacts on archaeological resources. Reports of damage to significant cultural resources (i.e., historic shipwrecks) have been confirmed in lease areas >200 m (656 ft) deep where no survey data were available. Although the exact cause of this damage is unknown, it may be linked to postlease, bottom-disturbing activities. As part of the environmental reviews conducted for postlease activities, available information will be evaluated regarding the potential presence of archaeological resources within a CPA proposed action area to determine if additional archaeological resource surveys and mitigation are warranted.

4.2.1.22.1. Historic

4.2.1.22.1.1. Description of the Affected Environment

With the exception of the Ship Shoal Lighthouse structure, historic archaeological resources on the OCS consist of historic shipwrecks. A historic shipwreck is defined as a submerged or buried vessel, at least 50 years old, that has foundered, stranded, or wrecked and that is currently lying on or is embedded in the seafloor. This includes vessels that exist intact or as scattered components on or in the seafloor.

The National Park Service (NPS) and this Agency contracted three studies (CEI, 1977; Garrison et al., 1989; Pearson et al., 2003) aimed at modeling areas in the GOM where historic shipwrecks are most likely to exist. The 1977 study concluded that two-thirds of the total number of shipwrecks in the northern Gulf lie within 1.5 km (1 mi) of shore and most of the remainder lie between 1.5 and 10 km (1 and 6 mi) of the coast (CEI, 1977). The 1989 study found that changes in the late 19th- and early 20th-century sailing routes increased the frequency of shipwrecks in the open sea in the eastern Gulf to nearly double that of the central and western Gulf (Garrison et al., 1989). The Garrison study also found the highest observed frequency of shipwrecks occurred within areas of intense marine traffic, such as the approaches and entrances to seaports and the mouths of navigable rivers and straits. Based on the results of this study, BOEM constructed a high-probability model for locations of archaeological potential to guide decisions regarding which OCS lease blocks would require the operator to submit an archaeological report with their EP, DOCD, DPP, or other permit application.

Pearson et al. (2003) benefited from the experience of almost 15 years of high-resolution, shallow hazard surveys in lease blocks (a typical lease block is 9 mi^2 [5,760 ac]) and along pipeline routes. Some of these surveys (almost exclusively for pipeline routes) were conducted in deep water. Several of these pipeline hazard surveys succeeded in locating historic ships, ranging in age from an 18th-century armed sailing ship to a World War II German U-boat. Taking these discoveries into account, the 2003 study then recommended including some deepwater areas, primarily on the approach to the Mississippi River, among those lease areas requiring archaeological investigation. With this in mind, BOEM revised its guidelines for conducting archaeological surveys and added about 1,200 lease blocks to the list of blocks requiring an archaeological survey and assessment. These requirements are posted on the BOEM website under NTL 2005-G07 and NTL 2008-G20. Since implementation of these new lease blocks on July 1, 2005, at least 39 possible historic sites have been reported in this area. In fact, in the last 5 years, over a dozen shipwrecks have been discovered through oil industry sonar surveys in water depths up to 9,800 ft (2,316 m), and nine of these ships have been confirmed visually as historic vessels.

Many of these wrecks were not previously known to exist in these areas from the historic record. Recent research on historic shipping routes, moreover, suggests that the ultra-deepwater area of the Gulf of Mexico, between 25º and 27.5º N. latitude, was located along the historic Spanish trade route, which therefore increases the probability that a historic shipwreck could be located in this area (Lugo-Fernandez et al., 2007). This route runs through the CPA proposed action area, and much of this area is not currently identified as requiring an archaeological assessment. A study to conduct archival research on these historic shipping routes was completed in 2010 (Krivor et al., 2011) and concluded that both Spanish and French vessels were lost in the 16th, 17th, and 18th centuries while transiting the route between Vera Cruz, New Orleans, and Havana.

The BOEM shipwreck database currently lists 959 wrecks in the CPA (**Table 4-77**). Many of these reported shipwrecks may be considered historic and could be eligible for nomination to the National Register of Historic Places. Most of these wrecks are known only through the historical record and, to date, have not been located on the ocean floor. This list should not be considered exhaustive. Regular reporting of shipwrecks did not occur until late in the 19th century, and losses of several classes of vessels, such as small coastal fishing boats, were largely unreported in official records. There have been 35 historic wrecks positively identified in the CPA, over half of which have been found in deepwater blocks in Mississippi Canyon, Green Canyon, and Viosca Knoll. Nearly all of these have been discovered as a result of BOEMRE-mandated oil industry surveys. The discoveries include two late 18th- to early 19th-century wooden sailing vessels, one lying in nearly 2,700 ft (823 m) of water (Atauz et al., 2006) and the other in 4,000 ft (1,219 m) of water (Ford et al., 2008). There are also several World War II casualties located in deep water off the mouth of the Mississippi River (e.g., *Alcoa Puritan, GulfPenn, Halo, Virginia, Robert E. Lee*, and the German submarine U-*166*) (Church et al., 2007). All of these wrecks have been investigated using a remotely operated vehicle from a surface vessel and are in an excellent state of preservation.

Historic shipwrecks also have been identified in shallow water in the CPA. One shipwreck, the steamship *Josephine* (22HR843), currently is listed to the National Register in the CPA (Irion and Ball, 2001); a second, the Spanish American War gunboat USS *Castine*, is awaiting final listing by the Keeper of the Register.

Submerged shipwrecks off the coasts of Louisiana, Mississippi, and Alabama are likely to be moderately well preserved because of the high sediment load in the water column from upland drainage and wind and water erosion. Wrecks occurring in or close to the mouth of bays likely would have been quickly buried by transported sediment and therefore somewhat protected from the destructive effects of wood-eating shipworms (*Teredo navalis*) or storms, as has been observed at the site of *La Belle* in Matagorda Bay, Texas, and the Emanuel Point wrecks in Pensacola Bay, Florida. A good example of this type of historic wreck is the Emanuel Point Wreck, believed to be part of Spanish explorer Tristan de Luna's fleet lost in Pensacola Bay in 1559 (Smith et al., n.d.; State of Florida, Division of Historic Resources, 2011). Wrecks occurring in deeper water also have a moderate to high preservation potential. In the deep water, temperature at the seafloor is extremely cold, which slows the oxidation of ferrous metals. While the cold water at depth would eliminate the wood-eating shipworm *Teredo navalis*, it is clear from recent studies that other marine organisms consume wooden shipwrecks and that microbial organism are at work breaking down steel and iron hulls (Atauz et al., 2006; Church et al., 2007; Church and Warren, 2008; Ford et al., 2008). Deepwater shipwreck discoveries continue to be made in the CPA off the mouth of the Mississippi River. Due to the high levels of preservation and the decrease in impacts from anthropogenic and meteorological events (e.g., diving, looting, trawling, hurricanes), the potential for recovery of archaeological data is considerably higher for shipwrecks discovered at depth as opposed to those found in nearshore environments.

Aside from acts of war, hurricanes cause the greatest number of wrecks in the Gulf. Wrecks occurring as a result of an extremely violent storm are more likely to be scattered over a broad area. The wreckage of the 19th-century steamer *New York*, which was destroyed in a hurricane, lies in 16 m (52 ft) of water off the coast of Mississippi and has been documented by BOEM (Irion and Anuskiewicz, 1999; Gearhart et al., 2011) as scattered over the ocean floor in a swath over 1,500 ft (457 m) long. Shipwrecks occurring in shallow water nearer to shore are more likely to have been reworked and scattered by subsequent storms than those wrecks occurring at greater depths on the OCS. Historic research indicates that shipwrecks occur less frequently in Federal waters. These wrecks are likely to be better preserved, less disturbed, and, therefore, more likely to be eligible for nomination to the National Register of Historic Places than are wrecks in shallower State waters.

Recent hurricane activity in the Gulf of Mexico is certain to have impacted archaeological resources in shallow water. It is almost certain that any shipwrecks within the path of Hurricanes Katrina or Rita in shallow water were impacted to some extent by these storms. In September 2005, NPS conducted a study of sites along the Gulf Coast that were impacted by Hurricane Katrina (USDOI, NPS, 2005). This assessment identified three types of damage that can occur to archaeological sites: tree throws; storm surge, scouring, and erosion; and seabed shifting. On the OCS, the two primary types of damage would be associated with storm surge and seabed shifting. Damage from either of these activities could adversely affect both prehistoric and historic sites on the OCS. In early 2007, this Agency awarded a study to investigate the impacts that recent storm activity may have had on historic shipwrecks in the Gulf of Mexico. Remote-sensing surveys for this study were completed in May 2007 and dive operations were completed in October 2007. A final report of findings was received in 2011. Analysis of the remote-sensing surveys and diver investigations indicates that at least 3 of the 10 shipwrecks examined were affected by recent storm activity and that older wooden wrecks that had achieved some level of equilibrium in their environment were less affected than more recent, steel-hulled wrecks (Gearhart et al., 2011). This study on impacts to shipwrecks from hurricanes or other storm activity was limited to SCUBA-diving depths of less than 130 ft (40 m). A potential result of hurricane activity in water depths greater than 130 ft (40 m) may include mud flows, erosion, and the generation of strong underwater currents or mega-furrows (Bryant and Liu, 2000, p. 52).

To date, there have been no data made publicly available regarding potential impacts from the DWH event on archaeological resources. No archaeological resources have been determined to be impacted to date. Samples were collected from a shipwreck site approximately 11 mi (18 km) from the Macondo well and approximately 600 yd (549 m) from an area of deepwater coral with visible oiling. Raw data and reports relating to these samples have not been released to the public. Spill-response activities may have impacted archaeological resources as well, but this appears to have been of limited concern on the OCS, as opposed to archaeological resources on land. There is anecdotal evidence that cleanup activities (such as the use of trucks) in the area of Fort Morgan may have impacted historic resources there.

Although there is incomplete or unavailable information on reasonably foreseeable impacts to historic archaeological resources, BOEM feels that this information is not essential to a reasoned choice among alternatives. The location of many archaeological resources remain unknown, some resources are heavily sedimented or buried and therefore protected from many impacts, and archaeological surveys, where required, are expected to be highly effective in identifying resources to allow for protection of the resource during oil and gas activities. Nevertheless, this incomplete or unavailable information is not likely to be available within the timeframe contemplated by this NEPA analysis. Hundreds of known historic archaeological resources are scattered throughout the Gulf and thousands more may exist, but their location is unknown to date. The costs of a Gulfwide study would be exorbitant and it could take years before data confirming the presence of additional historic archaeological resources and the status of each could be compiled and analyzed. In place of this incomplete or unavailable information, BOEM subject-matter experts have included what credibly scientific information is available and applied it using accepted scientific methodologies.

4.2.1.22.1.2. Impacts of Routine Events

Proposed Action Analysis

This section discusses the possible effects of routine activities associated with a CPA proposed action on archaeological resources. Routine impact-producing factors associated with a CPA proposed action that could affect historic archaeological resources include the direct physical contact with a shipwreck site, the placement of drilling rigs and production systems on the seafloor, pile driving associated with platform emplacement, pipeline emplacement, dredging of new channels, maintenance dredging of existing channels, anchoring activities, pipeline installation, structure removals and site clearance, and the masking of archaeological resources from industry-related debris.

Several OCS-related, impact-producing factors may cause adverse impacts to historic archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity, or anchors having an impact on a historic shipwreck. Direct physical contact with a wreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel’s crew, and the concomitant loss of information on maritime culture for the period from which the ship dates. Industry-related impacts have been found to have occurred in areas where remote-sensing surveys had not been previously required (Atauz et al., 2006; Church and Warren, 2008). Remote-sensing surveys of the seafloor using high-resolution sidescan sonar and magnetometers have been found to be an effective means of locating historic submerged properties in order to avoid impacts from the undertaking, in this case oil and gas development activities.

The placement of drilling rigs and production systems has the potential to cause physical impact to prehistoric and/historic archaeological resources. The area of seafloor disturbance from each of these structures is defined in **Chapter 3.1.1.2**. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

According to estimates presented in **Table 3-3**, 168-329 exploration and delineation wells and 215-417 development and production wells would be drilled, and 35-67 production platforms would be installed in support of a CPA proposed action. Of these, 86-167 exploration and delineation wells and 110-210 development and production wells would be drilled, and 31-60 platforms would be installed in water depths of 200 m (656 ft) or less, where the majority of blocks having the highest potential for historic period shipwrecks are located. While the expanded BOEM shipwreck database contains 959 reported shipwrecks in the entire CPA (**Table 4-77**), this number is believed to represent a fraction of the actual number of ships lost in the CPA. As noted above, recent research on historic shipping routes, moreover, suggests that the ultra-deepwater area of the Gulf of Mexico, between 25º and 27.5º N. latitude, was located along the historic Spanish trade route, which therefore increases the probability that a historic shipwreck could be located in this area (Lugo-Fernandez et al., 2007). This route runs through the CPA proposed action area. Of the 12,409 lease blocks in the CPA, less than 40 percent are leased. There are 2,332 blocks that fall within the Gulf of Mexico Region's current high-potential areas for historic resources in the CPA. Of these blocks, 812 are in water depths of 200 m (656 ft) or less and would require a survey at 50-m (164-ft) linespacing. There are 1,520 blocks in water depths that preclude a survey with a magnetometer and require sidescan-sonar survey at no more than a 300-m (984-ft) linespacing. The potential of an interaction between rig or platform emplacement and a historic shipwreck is greatly diminished by requisite site surveys. In certain circumstances, the BSEE Regional Director may require the preparation of an archaeological report to accompany pipeline applications under 30 CFR 250.1007(a)(5). The BOEM Regional Directors has authority to require certain types of surveys before submission of an EP, DPP, or DOCD under 30 CFR 550.194. As part of the environmental reviews conducted for postlease activities, available information will be evaluated regarding the potential presence of archaeological resources within the CPA proposed action area to determine if additional archaeological resource surveys and mitigation are warranted.

Pipeline placement has the potential to cause a physical impact to prehistoric and/or historic archaeological resources. Pipelines placed in water depths of less than 200 ft (61 m) must be buried. Burial depths of 3 ft (1 m) are required, with the exception of shipping fairways and anchorage areas, where the requirements are 10 ft (3.1 m) and 15 ft (4.6 m), respectively.

Maintenance dredging in support of activities resulting from a CPA proposed action has the potential to impact historic shipwrecks. Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. The BOEM estimates that, under a CPA proposed action, <1 percent of the ship traffic is related to OCS use. Therefore, the impact to archaeological sites directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. Proposed action activities represent <1 percent of the usage of the major navigation channels for the CPA.

Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that, during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipelaying barge.

Decommissioning trawling activities in support of structure removals have the potential to impact historic shipwrecks where no archaeological surveys were required in advance of structure placement. This is particularly true of older structures installed before current requirements were in place.

Activities resulting from a CPA proposed action would generate steel structures and debris, which would tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

Explosive seismic charges set off near historic shipwrecks may displace the surrounding sediments and cause loss of archaeological information regarding the context of the site. Furthermore, damage may result to the associated artifact assemblage.

Archaeological surveys, where required, are assumed to be effective in reducing the potential for an interaction between an impact-producing activity and a historic resource. The surveys are expected to be most effective in areas where there is only a thin veneer of unconsolidated Holocene sediments. In these areas, shipwreck remains are more likely to be exposed at the seafloor where they can be detected by the side-scan sonar as well as the magnetometer. In areas of thicker unconsolidated sediments, shipwreck remains are more likely to be completely buried, with detection relying solely on the magnetometer. With sites that are buried, and therefore more difficult to identify, the preservation potential is higher; thus, the potential for significant archaeological data is also higher. At the current survey linespacing requirement of 50 m, studies have concluded that a sizeable portion of shipwrecks would be detected on at least one survey line (Garrison et al., 1989; Enright et al., 2006, p. 129). By the same token, however, "small wooden-hulled vessels, whether machine- or sail-powered, are unlikely to be detected by 300-m (984-ft) surveys in most instances" (Enright et al., 2006, p. 129). In the CPA, 1,802 lease blocks are designated as having a high potential for containing submerged prehistoric sites, but a low potential for historic shipwrecks and are surveyed at a 300-m survey interval. In the CPA, 1,520 deepwater (>200 m; 656 ft) lease blocks, designated as having a high probability for containing shipwrecks, are beyond the practical range of magnetometers and are surveyed at 300-m (984-ft) linespacing using sidescan sonar.

Summary and Conclusion

The greatest potential impact to an archaeological resource as a result of a CPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, dredging, pipeline emplacement) and a historic site. Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, are expected to be effective at identifying possible archaeological sites. The technical requirements of the archaeological resource reports are detailed in NTL 2005-G07, "Archaeological Resource Surveys and Reports." Under 30 CFR 550.194(c) and 30 CFR 250.1010(c), lessees are required to notify BOEM and BSEE immediately of the discovery of any potential archaeological resources.

Offshore oil and gas activities resulting from a CPA proposed action could impact an archaeological resource because of incomplete knowledge on the location of these sites in the Gulf. The risk of contact to archaeological resources is greater in instances where archaeological survey data is unavailable. Such an event could result in the disturbance or destruction of important archaeological information. Archaeological surveys, where required, would provide the necessary information to develop avoidance strategies that would reduce the potential for impacts on archaeological resources.

Except for the projected 0-1 new gas processing plants and 0-1 new pipeline landfall, a CPA proposed action would require no new oil and gas coastal infrastructure. It is expected that archaeological resources would be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

4.2.1.22.1.3. Impacts of Accidental Events

Proposed Action Analysis

Impacts to a historic archaeological resource could occur as a result of an accidental spill. Impacts from a low-probability, high-volume catastrophic event are included in **Appendix B**. A major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. Although such effects may be temporary and reversible, cleaning oil from historic structures is by no means a simple or inexpensive process (e.g., Chin and Church, 2010). The use of dispersants, however, could result in chemical contamination of submerged cultural heritage sites. The effect, if any, of chemical dispersant use at the Macondo well site in 2010 on submerged shipwrecks is still not known although recent studies conducted by the Naval Research Laboratory concluded that hydrocarbon degraders are uniquely susceptible to COREXIT 9500 at environmentally relevant concentrations, while nonhydrocarbon degrading bacteria proliferate, possibly because of dispersant metabolism (Hamdan and Fulmer, 2011). The potential effects of chemical dispersants on microbes hastening the disintegration of shipwrecks are unknown. It is known that there are at least seven historically significant sites within

20 mi (32 km) of the well site. A recent site investigation of corals approximately 7 mi (11 km) from the Macondo well site revealed that the corals were impacted by the oiling event. “The proximity of the site to the disaster, the depth of the site, the clear evidence of recent impact, and the uniqueness of the observations all suggest that the impact found is linked to the exposure of this community to either oil, dispersant, extremely depleted oxygen, or some combination of these or other water-borne effects resulting from the spill” (Pennsylvania State University, 2010). A description of the impacted corals are described in **Chapter 4.2.1.10.1**. This has implications for the oiling of shipwreck sites and the microbiological organisms that are consuming these steel-hulled vessels. According to Church et al. (2007, p. 205), the observed bioaccumulation of oxidized forms of iron at the site of *Alcola Puritan*, generated by microbial activity in 2004 (located 12 mi [19 km] from the Macondo wellhead), was parallel to the degradation of the remains of RMS *Titanic*. It is unknown at this time, but it is hypothesized that microbial activity may be accelerated or retarded by compounds and elements associated with the release of millions of gallons of hydrocarbons and dispersants in the water column. At this time, little information is available on the condition of these shipwreck sites and the reaction to the oil spill. Additionally, there is also no information about the impacts of microbial activity on wooden shipwreck sites in deep water. Further study is warranted for both wooden shipwrecks and steel-hulled vessels to properly assess the impacts on these historically significant archaeological resources.

Other impacts that remain unknown at this time include the effect that the oiling of archaeological resources would have on the ability to conduct future chemical and observational analysis on the artifact assemblage. Currently, it is unknown if the release of hydrocarbons or of dispersant would impede the analysis that may help interpret and understand archaeological resources.

As noted above in the affected environment discussion, although information on the impacts of a potential spill to archaeological resources is incomplete or unavailable at this time and may be relevant to reasonably foreseeable adverse impacts on these resources, the information is not essential to a reasoned choice among alternatives. An oil spill occurring and contacting an archaeological resource is unlikely, given that oil released tends to rise quickly to the surface and that the average size of any spill would be small.

The major impacts to both coastal historic and prehistoric sites from the *Exxon Valdez* spill in Alaska in 1989 were related to cleanup activities such as the construction of helipads, roads, and parking lots and to looting by cleanup crews rather than from the oil itself (Bittner, 1996). As a result, cultural resources were recognized as significant early in the response to the DWH event, and archaeologists were embedded in SCAT’s and were consulting with cleanup crews. Although the process took several weeks to fully form, historic preservation representatives eventually were stationed at both the Joint Incident Command as well as each Area Command under the general oversight of the National Park Service to coordinate response efforts (Odess, official communication, 2010).

Summary and Conclusion

Accidental events producing oil spills may threaten archaeological resources along the Gulf Coast. Should a spill contact an historic archaeological site, damage might include direct impact from oil-spill cleanup equipment, contamination of materials, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches and offshore. It is not very likely for an oil spill to occur and contact submerged, coastal or barrier island historic sites as a result of a CPA proposed action.

The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. When oil is spilled in offshore areas, much of the oil volatilizes or is dispersed by currents, so it has a low probability of contacting coastal areas. It is expected that any spill cleanup operations would be considered a Federal action for the purposes of Section 106 of the NHPA and would be conducted in such a way as to cause little or no impacts to historic archaeological resources. Recent research suggests the impact of direct contact of oil on historic properties may be long term and not easily reversible without risking damage to fragile historic materials (Chin and Church, 2010).

The potential for spills is low, the effects would generally be localized, and the cleanup efforts would be regulated. A CPA proposed action, therefore, is not expected to result in impacts to historic archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact could be irreversible.

4.2.1.22.1.4. Cumulative Impacts

Of the cumulative scenario activities, those that could potentially impact historic archaeological resources include the following: (1) the OCS Program; (2) State oil and gas activity; (3) maintenance dredging; (4) OCS sand borrowing; (5) artificial rigs-to-reef development; (6) offshore LNG projects; (7) renewable energy and alternative use conversions; (8) commercial fishing; (9) sport diving and commercial treasure hunting, and (10) hurricanes.

Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a historic resource. The surveys are expected to be most effective in areas where there is only a thin veneer of unconsolidated Holocene sediments. In these areas, shipwreck remains are more likely to be exposed at the seafloor where they can be detected by the side-scan sonar as well as the magnetometer. In areas of thicker unconsolidated sediments, shipwreck remains are more likely to be completely buried with detection relying solely on magnetometer.

According to estimates presented in **Table 3-4**, an estimated 15,440-22,007 exploration, delineation, development, and production wells would be drilled, and 1,435-2,026 production platforms would be installed as a result of the OCS Program. Of this range, between 6,110 and 8,720 exploration, delineation, production, and development wells would be drilled, and 1,210-1,720 production structures would be installed in water depths of 60 m (196 ft) or less. The majority of lease blocks in this water depth have a high potential for historic shipwrecks. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that any major impacts on historic resources that were caused by OCS Program activities occurred from development prior to this time.

Of the 17,649 lease blocks in the OCS Program area, less than half of these blocks are leased. There are 2,938 blocks that fall within the Gulf of Mexico Region's currently designated, high-potential areas for archaeological resources. Of these blocks, 1,395 blocks are in water depths of 200 m (656 ft) or less and would require a survey at 50-m (164-ft) linespacing. The potential of an interaction between MODU or platform emplacement and a historic shipwreck is greatly diminished by requisite site surveys, where required, but it still exists in areas where surveys have not been required in the past. Such an interaction could result in the loss of or damage to significant or unique historic resources.

Table 3-4 indicates that the placement of between 18,907 and 43,340 km (11,748-26,930 mi) of pipelines is projected in the cumulative activity area. While the required archaeological survey minimizes the chances of impacting a historic shipwreck, there remains a possibility that a wreck could be impacted by pipeline emplacement. Such an interaction could result in the loss of significant or unique historic resources.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact historic wrecks. Archaeological surveys, when required, serve to minimize the chance of impacting historic wrecks; however, these surveys are not infallible and the chance of an impact from future activities does exist. Impacts from anchoring on a historic shipwreck may have occurred. There is also a potential for future impacts from anchoring on a historic shipwreck. Such an interaction could result in the loss of or damage to significant or unique historic resources and the scientific information they contain.

The probabilities of offshore oil spills ≥1,000 bbl occurring from OCS Program activities is presented in **Table 3-12 and Chapter 3.2.1.5.1**. Oil spills have the potential to impact coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. The impacts caused by oil spills to coastal historic archaeological resources are generally short term and reversible. **Tables 3-8 and 3-23** present coastal spills categorized by source. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related, commercial and recreational activities remain the same. Should such oil spills contact a historic site, the effects would likely be temporary and reversible.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high potential for historic shipwrecks; the greatest concentrations of historic wrecks are likely associated with these features (Pearson et al., 2003). It is reasonable to assume that significant or unique historic archaeological information has been lost as a result of past channel dredging activity. In many areas, COE requires remote-sensing surveys prior to dredging activities to minimize such impacts.

Past, present, and future OCS oil and gas exploration and development and commercial trawling would result in the deposition of tons of steel debris on the seafloor. Modern marine debris associated with these activities would tend to mask the magnetic signatures of historic shipwrecks, particularly in areas that were developed prior to requiring archaeological surveys. Such masking of the signatures characteristic of historic shipwrecks may have resulted or may yet result in OCS activities in the cumulative activity area impacting a shipwreck containing significant or unique historic information.

State oil and gas program wells, structures, and pipelines in State waters are not under the jurisdiction of BOEM with respect to the archaeological resource protection requirements of the NHPA. Under the NHPA, other Federal agencies, such as COE, which issues permits associated with pipelines in State waters, are responsible for taking into consideration the effects of activities permitted by such agencies on archaeological resources. Therefore, the impacts that might occur to archaeological resources by pipeline construction originating from OCS-related activity within State waters should be mitigated under the requirements of the NHPA, and the same archaeological surveys for planned pipelines that lead into a landfall or a tie-in to a pipeline in State waters are required. Prior to 1989, it is possible that explosive seismic surveys on the OCS and within State waters could have impacted historic shipwrecks. Explosive seismic charges set near historic shipwrecks could have displaced the vessel's surrounding sediments, acting like a small underwater fault and moving fragile wooden, glass, ceramic, and metal remains out of their initial cultural context. Such an impact would have resulted in the loss of significant or unique archaeological information.

Maintenance dredging takes place in existing, often well-used, and marked seaways and transit corridors within which any historic wrecks would have been already disturbed or their historical context destroyed. Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high potential for historic shipwrecks; the greatest concentrations of historic wrecks are likely associated with these features (Pearson et al., 2003). It is reasonable to assume that significant or unique historic archaeological information has been lost as a result of past channel dredging activity. In many areas, COE requires remote-sensing surveys prior to dredging activities to minimize such impacts. Routine maintenance dredging, as an ongoing activity in well-plied channels, is not likely to result in any new disturbance or disruption to historic wrecks.

The OCS sand borrowing is expected to be an activity on the increase during the OCS cumulative activities period. Approximately 76 million yd^3 of OCS sand is liable to be accessed for coastal restorations over the next 5-10 years from Ship Shoal Blocks 88 and 89 and from South Pelto Blocks 12 and 13, primarily. For these bottom-disturbing activities, a preconstruction archaeological survey is required by BOEM for the borrow site lease. No new disturbance of historic shipwrecks would be expected when the results of predeployment archaeological surveys of sand borrow sites are first examined for sea-bottom anomalies by BOEM so that the proper setback distances can be required that allow potential resources to be avoided.

Artificial reef development, offshore LNG projects, and renewable energy projects and alternative use conversions are expected to remain at, respectively, a steady pace of activity, to decrease, and to increase as competing uses of the OCS. A preconstruction archaeological survey is required before bottom-disturbing activities are permitted for artificial reef emplacement (if not reefed on site), deepwater ports for LNG facilities, and newly built renewable energy facilities. Alternative-use conversions of existing infrastructure likely would not involve new bottom-disturbing activities, but if called for in applications, a preconstruction survey would be required. No new disturbance of historic shipwrecks would be expected when predeployment archaeological surveys are first examined for sea-bottom anomalies by BOEM, or the permitting agency, so that proper setback distances can be required that allow mitigation potential resources to be avoided.

Commercial fishing trawling activity specifically would only affect the uppermost portions of the sediment column (Garrison et al., 1989) in water depths generally <600 ft (183 m). On many wrecks, the uppermost portions would already be disturbed by natural factors and would contain only artifacts that have lost all original context.

Sport diving, which is generally restricted to water depths <130 ft (40 m), and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. Efforts to educate sport divers and to foster the protection of historic shipwrecks, such as those of the Florida Keys National Marine Sanctuary and the Florida Public Archaeology Network, serve to lessen these potential impacts. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks within their diving limits. Since the extent of these activities is unknown, the impact cannot be quantified. A Spanish war vessel, *El Cazador*, was discovered in the CPA; it contained a large amount of silver coins and has been impacted by treasure hunting salvage operations (McLaughlin, 1995). The historic data available from this wreck and from other wrecks that have been impacted by treasure hunters and sport divers represent a localized significant or unique loss of archaeological information.

Hurricanes and tropical storms are normal occurrences in the GOM and along the Gulf Coast. On average, 15-20 hurricanes make landfall along the northern Gulf Coast per decade. Shipwrecks in shallow waters are exposed to a greatly intensified, longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts (e.g., ceramics and glass) would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information would also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms. Some of the data lost have most likely been significant or unique.

Summary and Conclusion

Several impact-producing factors may threaten historic archaeological resources, all related to bottom-disturbing activities. An impact could result from contact between a historic shipwreck located on the OCS and OCS Program or State oil and gas activities (i.e., pipeline and platform installations, drilling rig emplacement and operation, dredging, anchoring activities, structure removal, and site clearance). Bottom-disturbing activities on the OCS also include maintenance dredging, sand borrowing, transported artificial reef emplacement, LNG facility construction, and renewable energy facility construction. With the exception of maintenance dredging, preconstruction surveys may be required by BOEM or the permitting agency. Impacts resulting from the imperfect knowledge of the location of historic resources may still occur in areas where a high-resolution survey is only required at 984-ft (300-m) survey intervals or not at all. The OCS development prior to requiring archaeological surveys has been documented to have impacted wrecks containing significant or unique historic information. This was amply demonstrated when a pipeline was laid across a previously unknown early 19th-century shipwreck and when an MODU mooring anchor chain cut a shipwreck in half (Atauz et al., 2006; Church and Warren, 2008). The archaeological resources regulation at 30 CFR 250.194(c) and 30 CFR 550.194 grants authority in certain cases to each BOEM and BSEE Regional Director to require archaeological reports to be submitted with the EP, DOCD, or DPP where deemed necessary. As part of the environmental reviews conducted for postlease activities, available information will be evaluated regarding the potential presence of archaeological resources within the CPA proposed action area to determine if additional archaeological resource surveys and mitigation are warranted.

The loss or discard of steel debris associated with oil and gas exploration and development and trawling activities could result in the masking of historic shipwrecks or the identification of false negatives on archaeological surveys (an anomaly that does not appear to be of historical significance, but actually is).

Damage to or loss of significant or unique historic archaeological information from commercial fisheries (trawling) is highly likely in water depths <600 ft (183 m) (Foley, 2010). It is expected that maintenance dredging, commercial bottom trawling, sport-diving and commercial treasure hunting, and hurricanes and tropical storms have impacted and would continue to impact historic period shipwrecks on the shelf where such activities occur.

Development onshore as a result of a CPA proposed action could result in the direct physical contact between a historic site and pipeline trenching. It is assumed that archaeological investigations prior to construction would serve to mitigate these potential impacts. The expected effects of oil spills on historic coastal resources are temporary and reversible.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the localized loss of significant or unique historic archaeological information. In the case of factors related to OCS Program activities of the past within the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and site-clearance requirements). The incremental contribution of a CPA proposed action is expected to be very small due to the efficacy of remote-sensing surveys and archaeological report, where required. Future OCS Program activities and the bottom-disturbing activities permitted by BOEM and other agencies may require preconstruction archaeological surveys that, when completed, are highly effective in identifying bottom anomalies that could be avoided or investigated before bottom-disturbing activities begin. When surveys are not required, it is impossible to anticipate what might be imbedded in or lying directly on the seafloor, and impacts to these sites are likely to be major in scale. Despite diligence in site-clearance survey reviews, there is still the possibility of an unanticipated interaction between bottom-disturbing activity (i.e., rig emplacement, pipeline trenching, anchoring, and other ancillary activities) and a historic shipwreck. The incremental contribution of a CPA proposed action is expected to be very small due to the efficacy of the remote-sensing surveys and archaeological reports, where required.

4.2.1.22.2. Prehistoric

4.2.1.22.2.1. Description of the Affected Environment

Available evidence suggests that sea level in the northern GOM was at least 90 m (295 ft), and possibly as much as 130 m (427 ft), lower than present sea level during the period 20,000-17,000 years B.P. (Nelson and Bray, 1970). Sea level in the northern Gulf reached its present stand around 3,500 years B.P. (Pearson et al., 1986).

For the past 60 years, it was generally accepted by archaeologists that the earliest humans in North America were the so-called Clovis peoples, named for a lanceolate-shaped, fluted projectile point first found near Clovis, New Mexico. The Clovis culture was thought to have entered the continent by way of Beringia, a land mass connecting Asia to North America exposed during the Last Glacial Maximum, and along an ice-free corridor opened between the Cordilleran and Laurentide ice sheets around 13.5 thousand years before present. Today, however, a growing body of evidence has dispelled the “Clovis First” model with discovery of several sites with indisputable pre-Clovis dates in the eastern United States (Goodyear, 2005), Chile (Dillehay, 1989; Meltzer et al., 1997), and central Texas (Waters et al., 2011). The Buttermilk Creek Complex identified by Waters et al. (2011) at the Debra L. Friedkin Site (41BL1239) is the nearest to the Gulf of Mexico region and is dated from ~13.2 to 15.5 thousand years ago.

Establishing a reliable date for the entrance of Native Americans into the coastal regions of the Gulf is complicated by the fact that archaeological deposits pre-dating 3500 B.C. lie buried under as much as 40 m (131 ft) of sediment or are underwater on the OCS (Rees, 2010). Conclusive evidence for prehistoric sites of the Central Planning Area OCS is sparse. By analogy, the McFaddin Beach Site (41JF50) in Jefferson County, Texas, in the WPA has produced hundreds of artifacts 8,000 years old or older that have been redeposited from sites eroding from the now-submerged Pleistocene shoreline. Forty-three percent of the total sample include artifacts diagnostic of the Middle and Late Paleoindian periods and include Clovis, Dalton, Scottsbluff, and San Patrice projectile points (Stright et al., 1999). Because these artifacts come from a redeposited context and were selectively collected, it is impossible to determine if pre-Clovis sites may exist offshore.

Based on the best evidence currently available, the first Americans arrived on the Gulf Coast in the CPA around 11,500 B.C. (Aten, 1983; Rees, 2010) The sea-level curve for the northern GOM proposed by Coastal Environments, Inc. (CEI) suggests that sea level at 12,000 years B.P. would have been approximately 45-60 m (148-197 ft) below the present-day sea level (CEI, 1977 and 1982). On this basis, the continental shelf shoreward of the 45- to 60-m (148- to 197-ft) bathymetric contours has potential for prehistoric sites dating after 12,000 years B.P. Because of inherent uncertainties in both the depth of sea level and the entry date of prehistoric man into North America, this Agency adopted the 60-m (197-ft) water depth as the seaward extent for prehistoric site potential in the GOM region.

Based on their 1977 baseline study, CEI (1977) proposed that sites analogous to the types of sites frequented by Paleoindians can be identified on the now-submerged shelf. Geomorphic features that have a high potential for associated prehistoric sites include barrier islands and back-barrier embayments, river channels and associated floodplains and terraces, and salt-dome features. Remote-sensing surveys have been very successful in identifying these types of geographic features, which have a high potential for associated prehistoric sites. Recent investigations in Louisiana and Florida indicate the mound-building activity by prehistoric inhabitants may have occurred as early as 6,200 years B.P. (cf. Haag, 1992; Saunders et al., 1992; Russo, 1992). Therefore, manmade features, such as mounds, may also exist in the shallow inundated portions of the OCS.

Regional geological mapping studies by BOEM allow interpretations of specific geomorphic features and assessments of archaeological potential in terms of age, the type of system the geomorphic features belong to, and geologic processes that formed and modified them. The potential for site preservation must also be considered as an integral part of the predictive model. In general, sites protected by sediment overburden have a high potential for preservation from the destructive effects of marine transgression. The same holds true for sites submerged in areas subjected to low wave energy and for sites on relatively steep shelves, which were inundated during periods of rapid rise in sea level. Although many specific areas in the Gulf having a high potential for prehistoric sites have been identified through archaeological surveys, industry generally has chosen to avoid these areas rather than conduct further investigations.

Surveys from other areas of the western part of the CPA have produced evidence of floodplains, terracing, and point-bar deposits in association with relict late Pleistocene fluvial systems. Prehistoric sites associated with these features would have a high potential for preservation. Salt diapirs with bathymetric expression have also been recorded during lease-block surveys in this area. Solution features at the crest of these domes would have a high potential for preservation of associated prehistoric sites. The Salt Mine Valley site on Avery Island is a Paleoindian site associated with a salt-dome solution feature (CEI, 1977). The proximity of most of these relict landforms to the seafloor facilitates further investigation and data recovery.

The Holocene history of southeastern Louisiana is extremely complex and characterized by overlapping deltaic lobes. Prehistoric terrestrial sites inhabited during active build out of the old deltas and during early stages of their deterioration can be anticipated in shallow shelf areas. A large number of prehistoric sites have likely been encapsulated in the alluvial deposits of older deltaic lobes but through a combination of subsidence, and rapid deposition could be buried by as much as 300 ft (91 m) of Holocene sediment.

A good-faith effort was made to identify any impacts to known prehistoric sites in the CPA as a result of recent hurricane activity; however, no such information was identified. It is unlikely that Hurricane Katrina would have affected any prehistoric sites on the OCS because of the deep burial of the Pleistocene surface.

As noted in **Chapter 4.2.1.22.1.1**, to date there have been no data made publicly available regarding potential impacts from the DWH event on archaeological resources. No archaeological resources have been determined to be impacted to date. Spill-response activities may have impacted archaeological resources as well, but this appears to have been of limited concern on the OCS, as opposed to archaeological resources on land or near the coast. For example, there is anecdotal evidence that cleanup activities (such as the use of trucks) in the area of Fort Morgan may have impacted historic resources there.

Although there is incomplete or unavailable information on reasonably foreseeable impacts to prehistoric archaeological resources, BOEM feels that this information is not essential to a reasoned choice among alternatives. The location of many prehistoric archaeological resources remain unknown, and those that have been identified are subject to Federal and State protections. Nevertheless, this incomplete or unavailable information is not likely to be available within the timeframe contemplated by this NEPA analysis. There are numerous prehistoric archaeological resources scattered throughout the Gulf Coast and more may exist, but their locations and conditions are unknown to date. The costs of a Gulfwide study would be exorbitant and it could take years before data confirming the presence of additional historic archaeological resources and the status of each could be compiled and analyzed. In place of this incomplete or unavailable information, BOEM subject-matter experts have included what credibly scientific information is available and applied it using accepted scientific methodologies.

4.2.1.22.2.2. Impacts of Routine Events

Proposed Action Analysis

Blocks with a high potential for prehistoric archaeological resources are found landward of the 12,000-years-B.P. shoreline position, which is roughly approximated by the last geologic still-stand before inundation at approximately 13,000 years B.P. This 13,000-years-B.P. still-stand also roughly follows the 148-ft (45-m) bathymetric contour. Because of inherent uncertainties in both the depth of historic sea-level stands and the entry date of prehistoric man into North America, BOEM has adopted the 197-ft (60-m) water depth as the seaward extent of the area considered to have potential for prehistoric archaeological resources.

Offshore development as a result of a CPA proposed action could result in an interaction between a drilling rig, platform, pipeline, dredging activity, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenance and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

The placement of drilling rigs and production systems has the potential to cause physical impact to prehistoric archaeological resources. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric archaeological resources. Pipelines placed in water depths of <200 ft (60 m) must be buried. Burial depths of 3 ft (1 m) are required, with the exception of shipping fairways and anchorage areas, where the requirements are 10 ft (3.1 m) and 15 ft (5 m), respectively. Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric archaeological resources. It is assumed that, during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipelaying barge.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. Prehistoric sites that have yet to be identified would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of a CPA proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region.

Since all platform locations within the high-potential areas for the occurrence of offshore prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to prehistoric archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities*, *Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Except for the projected 0-1 new gas processing plant and 0-1 new pipeline landfall, a CPA proposed action would require no new oil and gas coastal infrastructure. Any facility constructed must receive approval from the pertinent Federal, State, county, and community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There should, therefore, be no impact to onshore prehistoric sites from onshore development related to a CPA proposed action.

In order to reduce the risk of impacting a prehistoric archaeological resource during a BOEM- or BSEE-permitted activity, both agencies require a 300-m (984-ft), remote-sensing survey linespacing for lease blocks that have been identified as having a high potential for containing prehistoric resources. The current NTL—NTL 2005-G07, effective July 1, 2005—supersedes all other archaeological NTL's and Letters to Lessees and Operators, and it clarifies the updated information to reflect current technology. The list of lease blocks requiring an archaeological survey and assessment are identified in NTL 2008-G20.

Summary and Conclusion

The greatest potential impact to an archaeological resource as a result of a CPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, dredging, pipeline emplacement) and a prehistoric site. Prehistoric archaeological sites are thought potentially to be preserved shoreward of the 45-m (148-ft) bathymetric contour, where the Gulf of Mexico continental shelf was subaerially exposed during the Late Pleistocene. The archaeological survey and archaeological clearance of sites, where required prior to an operator beginning oil and gas activities on a lease, are expected to be somewhat effective at identifying submerged landforms that could support possible archaeological sites. The NTL 2005-G07 suggests a 300-m (984-ft) linespacing for remote-sensing surveys of leases within areas having a high potential for prehistoric sites. While surveys, where required, provide a reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric archaeological site, there is a possibility of an OCS activity contacting an archaeological site because of an insufficiently dense survey grid. Should such contact occur, there would be damage to or loss of significant and/unique archaeological information.

4.2.1.22.2.3. Impacts of Accidental Events

Proposed Action Analysis

Oil spills resulting from a well blowout in the CPA and related spill-response activities have the potential to impact cultural resources near the spill site and landfall areas. Impacts from a low-probability, high-volume catastrophic event are included in **Appendix B**. Although information on the actual impacts from the DWH event are inconclusive at this time, it is expected that impacts on prehistoric archaeological sites have occurred through hydrocarbon contamination of organic materials, which have the potential to date site occupation through radiocarbon-dating techniques, as well as possible physical disturbance associated with spill cleanup operations. Since archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts on archaeological resources, given recent experience.

The major impacts to prehistoric sites from the *Exxon Valdez* spill in Alaska in 1989 were related to cleanup activities such as the construction of helipads, roads, and parking lots and to looting by cleanup crews rather than from the oil itself (Bittner, 1996). As a result, cultural resources were recognized as significant early in the response to the DWH event, and archaeologists were embedded in SCAT's and were consulting with cleanup crews. Although the process took several weeks to fully form, historic preservation representatives eventually were stationed at both the Joint Incident Command as well as each Area Command under the general oversight of the National Park Service to coordinate response efforts (Odess, official communication, 2010). However, should an oil spill directly contact a coastal prehistoric site, unique or significant archaeological information could be lost, and this impact would be irreversible.

As noted above in the affected environment discussion, although information on the impacts of a potential spill to archaeological resources is incomplete or unavailable at this time and although it may be relevant to reasonably foreseeable adverse impacts on these resources, the information is not essential to a reasoned choice among alternatives. Most OCS activities are far removed from prehistoric sites, and an oil spill occurring and contacting an archaeological resource is unlikely, given that oil released tends to rise to the surface quickly, would generally not reach coastal and nearshore areas and the average size of any spill would be small.

Summary and Conclusion

Accidental events producing oil spills may threaten archaeological resources along the Gulf Coast. Should a spill contact a prehistoric archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches. Detailed risk analyses of offshore oil spills ranging from ≥1,000 bbl, <1,000 bbl, and coastal spills associated with a CPA proposed action is provided in **Chapters 3.2.1.1, 3.2.1.2, and 3.2.1.3**, respectively. When oil is spilled in offshore areas, much of the oil volatilizes or is dispersed by currents, so it has a low probability of contacting coastal and barrier island prehistoric sites as a result of a CPA proposed action. A CPA proposed action, therefore, is not expected to result in impacts to prehistoric archaeological sites.

4.2.1.22.2.4. Cumulative Impacts

Future OCS exploration and development activities in the Gulf of Mexico between 2012 and 2051, which can be found in **Table 3-4**, projects drilling 6,110-8,720 exploration, delineation, development, and production wells in water depths <60 m (197 ft). Relative sea-level curves for the Gulf of Mexico indicate that, based on our current understanding of when humans first arrived on the Gulf Coast, there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m (197 ft). Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, are assumed to be highly effective in reducing the potential for an interaction between an impact-producing factor and a prehistoric resource. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that the major impacts to prehistoric resources that may have occurred resulted from development prior to this time. The potential of an interaction between rig or platform emplacement and a prehistoric site is diminished by the survey, but it still exists. Such an interaction would result in the loss of or damage to significant or unique prehistoric information.

For the OCS Program, 6,513-13,124 km (4,047-8,155 mi) of pipelines are projected in water depths <60 m (197 ft) for the years 2012-2051. While archaeological surveys minimize the chances of impacting a prehistoric site, there remains a possibility that a site could be impacted by pipeline emplacement. Such an interaction would result in the loss of significant or unique archaeological information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact shallowly buried prehistoric sites. Archaeological surveys minimize the chance of impacting these sites; however, these surveys are not seen as infallible, and the chance of an impact from future activities exists. Impacts from anchoring on a prehistoric site may have occurred. Such an interaction could result in the loss of significant or unique archaeological information.

The probabilities of offshore oil spills ≥1,000 bbl occurring from the OCS Program in the cumulative activity area is presented in **Chapter 3.2.1.5.1**. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. Coastal, oil-spill scenario numbers are presented in **Tables 3-8 and 3-23** and are categorized by source. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related, commercial and recreational activities remain the same. There is a small possibility of these spills contacting a prehistoric site. The impacts caused by oil spills to coastal prehistoric archaeological resources can severely distort information relating to the age of the site. Contamination of the organic site materials by hydrocarbons can make radiocarbon dating of the site more difficult or even impossible. This loss might be ameliorated by using artifact seriation or other relative dating techniques. Coastal prehistoric sites might also suffer direct impact from oil-spill cleanup operations as well as looting resulting from interactions between persons involved in cleanup operations and unrecorded prehistoric sites. Interaction between oil-spill cleanup equipment or personnel and a site could destroy fragile artifacts or disturb site context, possibly resulting in the loss of information on the prehistory of North America and the Gulf Coast region. Some coastal sites may contain significant or unique information.

Most channel dredging occurs at the entrances to bays, harbors, and ports. Bay and river margins have a high potential for the occurrence and preservation of prehistoric sites. Prior channel dredging has disturbed buried and/inundated prehistoric archaeological sites in the coastal plain of the Gulf of Mexico. It is assumed that some of the sites or site information were unique or significant. In many areas, COE requires surveys prior to dredging activities to minimize such impacts.

Trawling activity would only affect the uppermost portion of the sediment column (Garrison et al., 1989). This zone would already be disturbed by natural factors, and site context to this depth would presumably be disturbed. Therefore, no effect of trawling on prehistoric sites is assumed. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Table 3-4 indicates the projected coastal infrastructure related to OCS Program activities in the cumulative activity area. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Because BSEE does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within BSEE's jurisdiction. Under the NHPA, other Federal agencies, such as COE, which permits pipelines in State waters, are responsible for taking into consideration the effects of activities permitted by such agencies on archaeological resources. Therefore, the impacts that might occur to archaeological resources by pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Over 100 hurricanes have made landfalls along the northern Gulf of Mexico coast from the Florida Panhandle to Texas over the past century (Liu and Fearn, 2000; Keim and Muller, 2009). Prehistoric sites in shallow waters and on coastal beaches are exposed to the destructive effects of wave action and scouring currents. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed. Some of the original information contained in the site would be lost in this process. Overall, loss of data from prehistoric sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms.

Summary and Conclusion

Several impact-producing factors may threaten prehistoric archaeological resources of the Gulf of Mexico. An impact could result from contact between proposed oil and gas activities (including pipeline construction, platform installation, drilling rig emplacement and operation, dredging, and anchoring activities) and an oil spill and subsequent cleanup efforts. Each of these activities or events could damage and destroy a prehistoric archaeological site located on the continental shelf. Archaeological surveys, where required, and the resulting archaeological analyses completed prior to an operator beginning oil and gas activities on a lease are expected to be highly effective at identifying possible prehistoric sites. The OCS development prior to the first required archaeological survey in 1973 has possibly impacted sites containing significant or unique prehistoric information, and it is possible that, even with current survey methods, prehistoric archaeological sites may be missed. No significant new information was found at this time that would alter the overall conclusion that cumulative impacts on prehistoric archaeological sites associated with a CPA proposed action is expected to be minimal. Because of continued regulations and surveys, where required, potential impact from a CPA proposed action to prehistoric archeological resources would be decreased.

Should an oil spill occur and contact a coastal prehistoric site, loss of significant or unique information could result. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations.

The initial dredging of ports and navigation channels and tropical storms are assumed to have caused the localized loss of significant or unique archaeological information.

Onshore development as a result of the OCS Program could result in the direct physical contact between a prehistoric site and new facility construction and pipeline trenching. It is assumed that archaeological investigations prior to construction would serve to mitigate these potential impacts.

The shallow depth of sediment disturbance caused by commercial fisheries activities (trawling) is not expected to exceed that portion of the sediments that have been disturbed by wave-generated forces.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in localized losses of significant or unique prehistoric archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of a CPA proposed action is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

4.2.1.23. Human Resources and Land Use

4.2.1.23.1. Land Use and Coastal Infrastructure

Oil and gas exploration, production and development activities on the OCS are supported by an expansive onshore infrastructure industry that includes large and small companies providing a wealth of services from construction facilities, service bases, and waste disposal facilities to crew, supply, and product transportation, as well as processing facilities. Analysis of the affected environment covers thirteen different infrastructure categories that support thousands of jobs representing both direct and indirect economic impacts that ripple through the Gulf Coast economy. The OCS related infrastructure, a long-standing part of these regional economies that developed over the past several decades, is quite mature.

A CPA proposed action would not require additional coastal infrastructure, with the possible exception of 0-1 new gas processing facility and 0-1 new pipeline landfall, and it would not alter the current land use of the analysis area. In fact, as industry responds to the post-DWH environment, increased scrutiny of industry practices, and regulatory revisions, the 0-1 projection range becomes even more conservative, i.e., it becomes even more likely that the number would be zero (Dismukes, official communication, 2011a). Thus, the existing oil and gas infrastructure is expected to be sufficient to handle development associated with a CPA proposed action. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle such development. There is also sufficient land to construct a new gas processing plant in the unlikely event that one should be needed. However, because the current spare capacity at existing facilities should be sufficient to satisfy new gas production, any such need would likely materialize only toward the end of the 40-year life of a CPA proposed action

(Dismukes, official communication, 2011d). This excess capacity substantially diminishes the likelihood of new facility construction. Existing solid-waste disposal infrastructure is adequate to support both existing and projected offshore oil and gas drilling and production needs. Minor accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no long-term negative effects on land use. Coastal or nearshore spills, as well as vessel collisions, could have short-term adverse effects on coastal infrastructure, requiring the cleanup of any oil or chemicals spilled. The incremental contribution of a CPA proposed action to the cumulative impacts on land use and coastal infrastructure are expected to be minor. A full catastrophic event analysis of impacts from an event such as the DWH event can be found in **Appendix B**.

4.2.1.23.1.1. Description of the Affected Environment

Socioeconomic Analysis Area

The BOEM defines the analysis area for potential impacts on population, labor, and employment as that portion of the GOM coastal zone where social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. In this description of the socioeconomic environment, sets of counties (and parishes in Louisiana) have been grouped on the basis of intercounty commuting patterns into Labor Market Areas (LMA's), as identified by Tolbert and Sizer (1996). In their research, Tolbert and Sizer (1996) used journey-to-work data from the 1990 census to construct matrices of commuting flows from county to county. A statistical procedure known as hierarchical cluster analysis was employed to identify counties that were strongly linked by commuting flows. The researchers identified 741 of these commuting zones for the U.S. Along the Gulf Coast, from the southern tip of Texas to Miami and the Florida Keys, 23 LMA's are identified and comprise the 13 BOEM-defined Economic Impact Areas (EIA's) for the Gulf of Mexico region. The counties and parishes that form the LMA's and EIA's are listed in **Table 4-34** and the EIA's are visually illustrated in **Figure 4-20**.

The LMA's geographically adjacent to the CPA include Lake Charles, Lafayette, Baton Rouge, Houma and New Orleans, Louisiana; Biloxi-Gulfport, Mississippi; and Mobile, Alabama. Use of the LMA geography brings together not only counties immediately adjacent to the GOM but also counties tied to coastal counties as parts of functional economic areas. An analysis that encompasses where people live as well as where they work permits a more meaningful assessment of the impact of offshore oil and gas activities. Because exploration, development, and production activities on the OCS draw on existing infrastructural, economic, and labor capacity from across the GOM region, the socioeconomic impacts of a proposed action are not limited to geographically adjacent areas. The BOEM's impact analysis considers the potential impacts in all 13 EIA's regardless of where a proposed action is taking place.

The BOEM has funded an ongoing study to more clearly delineate EIA's by establishing a clear, explicit, empirical rationale to guide and support impact assessments of industry operations and activities. Results of the study will not be received in time to be used in this EIS, but they will be available for modification of BOEM's environmental impact assessment methodology in future NEPA reviews.

Land Use

For a CPA proposed action, the primary region of geographic influence is coastal Louisiana, Mississippi, and Alabama. Oil and gas activities are quite limited in the Florida area. The coastal zone of the northern GOM is not a physically, culturally, or economically homogenous unit (Gramling, 1984). The counties and parishes along the coasts of Louisiana, Mississippi, Alabama, and Florida represent some of the most valuable coastline in the U.S. Not only does it include miles of recreational beaches and the protection of an extended system of barrier islands, but it also has deepwater ports, oil and gas support industries, manufacturing, farming, ranching, and hundreds of thousands of acres of wetlands and protected habitat. These counties and parishes vary in their histories and in the composition and economic activities of their respective local governments.

Figures 4-22 and 4-46 illustrate the analysis area's key infrastructure. Major cities in the analysis area include Lake Charles, Lafayette, Baton Rouge and New Orleans, Louisiana; Pascagoula, Mississippi; and Mobile, Alabama. Several international and regional airports are located throughout the analysis area. One major interstate (I-10) traverses the area along the inner margin of the coastal zone, while five interstate highways access the area longitudinally. There are numerous highways into and across the analysis area. The most significant is Louisiana Highway 1 (LA Hwy 1) that provides the only link between Port Fourchon, Louisiana, and the rest of the Nation. Port Fourchon occupies an important position in the critical energy infrastructure of the United States. This fact was recognized nationally in 2001 when Congress added Port Fourchon to the Federal list of "High Priority Corridors" (LA1 Coalition, 2011a). This two-lane highway is surrounded by marshland and has been prone to extreme flooding over the years. Port Fourchon is the service base for over 90 percent of OCS deepwater production and serves as a conduit for 15-18 percent of the Nation's entire oil supply (The Greater Lafourche Port Commission, 2011). A multiphase LA Hwy 1 improvement project is currently underway (LA1 Coalition, 2011b). The area's railroad configuration is similar to the highway system. An extensive maritime industry exists in the analysis area. There is a substantial amount of domestic waterborne commerce in the analysis area and also some foreign maritime traffic. For the year 2009, 8 of the leading 25 U.S. ports ranked by total trade tonnage are located in Louisiana, Mississippi, Alabama, and Florida (American Association of Port Authorities, 2009).

The Louisiana coastal area includes broad expanses of coastal marshes and swamps interspersed with ridges of higher well-drained land along the courses of modern and extinct river systems. Most of the urban centers in coastal Louisiana are located along major navigable rivers and along the landward edge of the coastal zone (i.e., Lafayette and Lake Charles). Southwestern Louisiana is Acadian country. The area's natural features vary from marshland, waterways, and bayous in the coastal areas to flat agricultural lands in the northern part of the same parishes. While the area's traditionally strong ties to agriculture, fishing, and trapping are still evident, they are no longer the mainstay of the economy. Southeastern Louisiana, from Jefferson Parish east to St. Tammany Parish and the State border with Mississippi, is a thriving metropolitan area with shipping, navigation, U.S. Navy facilities, and oil and chemical refineries, all vying with local residents for land. Historically, Terrebonne, Plaquemines, and Lafourche Parishes have been the primary staging and support area for offshore oil and gas exploration and development. The Port of Fourchon, at the mouth of Bayou Lafourche on the GOM, is a major onshore staging area for OCS oil and gas activities in the CPA, and it is the headquarters of the Louisiana Offshore Oil Port (LOOP), which offloads 10-15 percent of U.S. foreign oil imports and transports that oil to half of the Nation's refining capacity (The Greater Lafourche Port Commission, 2011).

Coastal Mississippi is characterized by bays, deltas, marshland, and waterways. Two thirds of this coast is devoted to State-chartered gambling barges and heavy tourism along the beachfront. The remaining third (Jackson County) is industrial—oil refining and shipbuilding. Upland portions of the three coastal counties—Hancock, Harrison, and Jackson—are timberlands. Jackson County has a strong industrial base and designated industrial parks. Pascagoula, in Jackson County, is home to Ingalls Shipyard and Chevron Pascagoula Refinery. Bayou Casotte, also in Jackson County, currently has boat and helicopter facilities, and the onshore support base for drilling and production. Bayou Casotte also hosts the Gulf LNG Energy's liquefied natural gas facility, which is on schedule to be completed by the end of 2011 (Wilkinson, 2010).

Southwestern Alabama's coastline is comprised of Mobile and Baldwin Counties, which oppose each other across Mobile Bay. Coastal resource-dependent industries in this area include navigation, tourism, marine recreation, commercial fishing, and offshore natural gas development and production. Large quantities of natural gas were discovered in Alabama's offshore waters in 1979. Baldwin County has a strong tourism economy and a large retiree population. The important commercial fishing industry in the area is located in southeastern Mobile County. The Port of Mobile, the largest seaport in Alabama, is also in Mobile County. The military has had a long presence in the area. The buildup and downsizing of military installations has handed the area some special challenges. There are several oil- and gas-related businesses, including Mobil's MaryAnn/823 plant, established in 1990, and Shell's Yellowhammer plant, founded in 1989; both of these plants process natural gas (Wade et al., 1999). The Yellowhammer plant is located about 20 mi (32 km) south of Mobile on 40 ac (16 ha) of land near Coden, Alabama (Shell, 2011). According to the most recent statistics from the U.S. Dept. of Agriculture's Economic Research Service, which classifies counties into economic types that indicate primary land-use patterns, 3 of the 90 counties/parishes in the analysis area are classified as farming dependent, 6 as mining dependent (suggesting the importance of oil and gas development to these local economies), 19 as manufacturing dependent, 24 as government employment centers, 20 as tied to service employment, and 18 as nonspecialized. The Economic Research Service also classifies counties in terms of their status as a retirement destination; 29 of the 90 counties/parishes are considered major retirement destinations (U.S.

Dept. of Agriculture, Economic Research Service, 2004). The varied land-use patterns are displayed in **Figure 4-23**.

OCS-Related Coastal Infrastructure

The OCS-related onshore coastal infrastructure is extensive, covers a wide-ranging area, supports OCS development, and consists of thousands of large and small companies. These companies cover every facet of OCS activity, including, but not limited to, platform fabrication, shipbuilding and repair, pipelines, pipe coating, service bases, ports, waste disposal facilities, natural gas storage, gas processing plants, service vessels, heliports, terminals, refineries, and petrochemical plants. For analysis purposes, these infrastructure types are organized into the following categories: construction facilities; OCS support facilities; transportation; and processing facilities.

Construction Facilities

Unless otherwise indicated, the following information is from BOEM's three OCS Gulf of Mexico Fact Books: (1) *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (The Louis Berger Group, Inc., 2004); (2) *Fact Book: Offshore Oil and Gas Industry Support Sectors* (Dismukes, 2010); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, 2011b). The major players among OCS-related construction facilities include platform fabrication yards, shipyards, and pipecoating plants and yards.

Platform Fabrication Yards

Facilities where platforms (and drilling rigs) are fabricated are called platform fabrication yards. Most platforms are fabricated onshore and then towed to an offshore location for installation. Production operations at fabrication yards include the cutting and welding of steel components and the construction of living quarters and other structures, as well as the assembly of platform components, to support both exploration and production activities.

Fabrication yards build drilling rigs for offshore exploration. Early drilling rigs consisted of a derrick fitted to a barge and towed to a drilling site. Today, four common types of offshore drilling rigs include submersibles, jackups, drill ships, and semisubmersibles. Submersibles are one of the earliest forms of offshore drilling rigs used especially in shallow coastal zones or inland waters. Submersibles are towed to shallow water locations then ballasted to the seabed by flooding them with water. Jackups are quite mobile and common. A jackup lowers long metal legs to the sea floor and then the hull is jacked-up above the water's surface. Jackups can be used normally in water up to 525 ft (160 m) in depth. Drill ships are more advanced drilling structures that are floating marine craft with a derrick on top and a moon pool in the center of the hull for drilling operations. They are anchored and/or positioned with computers and GPS systems that continually correct the ship's drift. Drill ships are often used to drill wildcat wells in deep waters. Semisubmersibles can be used for production as well as drilling activities. These structures are supported by columns sitting on hulls or pontoons, which are ballasted with water below the ocean surface to provide stability in rough, deep waters.

When an oil and/or gas discovery occurs, an exploratory drilling rig will be either replaced with, or converted to, a production platform assembled at the site using a barge equipped with heavy lift cranes. Often in deepwater areas, drilling and production occur on the same structure (such as semisubmersibles). **Figure 3-3** illustrates the various types of platforms used in deepwater production and development. Depending on the size of the field discovered, the water depth, and the distance from shore, platforms will vary in size, shape, and type, ranging from fixed platforms in shallow water all the way to subsea systems and floating production, storage and offloading systems (FPSO's) in deeper waters.

A fixed platform is the most common production system in GOM shallow waters. Fixed platform fabrication can be subdivided into two major tasks: jacket fabrication and deck fabrication. The jacket is constructed by welding together steel plates and tubes to form a tower-like skeletal structure. Because the height of a jacket is several hundred feet, jackets are made lying horizontally on skid runners. Once the jacket is completed, it is pulled over, maintaining the same horizontal position, to a barge that transports it to an offshore location where the jacket is installed. Along with the jacket is the construction of smaller ancillary structures such as pile guides, boat landings, walkways, buoyancy tanks, handrails, etc. These structures are attached to the jacket while it is still in a horizontal position.

The deck is fabricated separately from the jacket. A typical deck is a flat platform supported by several vertical columns (deck legs). The deck provides the necessary surface to place production equipment, living quarters, and various storage facilities. Once the deck fabrication is completed, it is loaded onto a barge and transported to the site of the platform, where it is lifted by derrick barges and attached to the already installed jacket.

The metal jacket attaches to the ocean bottom with piles, and the topside deck is located above the water and accommodates drilling, production, support equipment, and living quarters. Fixed platforms are typically installed in water depths of up to 2,000 ft (610 m). In deep water (water depths >1,000 ft; 305 m), it is much less common to use fixed platforms. As of 2008, there were only five fixed platforms in service in deepwater areas (USDOI, MMS, 2009d).

A compliant tower is similar to a fixed platform, but the underwater section is not a jacket. It is a narrow, flexible tower that can move (or is compliant) around in the horizontal position allowing for a limited range of motion created by winds and wave action. Compliant towers are typically installed in water depths from 1,000 up to 2,000 ft (305 to 610 m), but they can be installed in water depths up to 3,000 ft (914 m). Some have an upper jacket with buoyant sections and mooring lines to the seafloor to stabilize it (USDOI, MMS, 2000c). Data available from 2008 indicate that there are three compliant tower platforms operating in deep water (USDOI, MMS, 2009d).

Based upon the semisubmersible technology, tension and mini-tension leg platforms (TLP's) are floating structures. A TLP is a ship-based type of structure that is towed to its location and anchored to the seabed with vertical, taut steel cables or solid pipes. The TLP's are distinguished from free floating platforms in that wellheads can be placed on the TLP's deck. In 2008, there were 18 TLP's operating in deep water (USDOI, MMS, 2009d).

The SPAR platforms are designed to facilitate deepwater production in potentially up to 10,000 ft (3,048 m) in water depth. The SPAR's consist of a large vertical hull, moored to the ocean floor with up to 20 lines. Production equipment and living quarters are located on the top of the hull. There were 15 SPAR platforms in deepwater production as of 2008 (USDOI, MMS, 2009d).

A floating production system (FPS) is a variation of a semisubmersible and is kept stationary either by anchoring with wire ropes and chains or by the use of rotating thrusters, which self-propel the semisubmersible unit. Floating production systems are suited for deepwater production in depths up to 7,500 ft (2,286 m). In the Gulf of Mexico, BP's Thunder Horse began production in March 2009 and is designed with equipment and systems to treat and export 250,000 bbl/day of oil plus associated gas (Waggoner, 2009). The use of FPS's increased significantly in 2007, with 9 out of 16 new projects adopting the FPS production system (USDOI, MMS, 2009d).

A subsea system consists of a single subsea well or several producing wells connected (tied back) to either a nearby platform or a distant production facility (e.g., TLP and SPAR) through a pipeline, umbilical, and manifold system. Subsea systems have proven to be the most utilized form of development system in use for deepwater projects, especially in ultra-deepwater, where water depths exceed 5,000 ft (1,524 m) (USDOI, MMS, 2009d).

Originally developed for North Sea applications, an FPSO system consists of a large vessel housing production equipment to collect and store oil produced from several subsea wells. Eventually the oil is offloaded to a shuttle tanker for transportation to markets for refining and distribution. The FPSO systems are particularly useful in development of remote (or frontier) oil fields where pipeline infrastructure is not available. In March 2011, BOEMRE approved the first FPSO for the Gulf of Mexico—the Petrobras America Cascade-Chinook Project located about 165 mi (266 km) offshore in the Walker Ridge area. It has a production capacity of 80,000 bbl of oil per day and 16 million cubic feet (MMcf) of natural gas per day (Rigzone, 2011). However, first production, originally projected for June 2011, was delayed because of a problem with the buoyancy can on the Chinook free-standing riser. The FPSO's are not vulnerable to hurricane activity because they can disconnect from their subsea wells and return to shore in advance of a hurricane (Troy, 2011a).

Given the large size of offshore platforms, fabrication yards necessarily span several hundred acres, as they must facilitate large construction projects and maintain an inventory of construction components such as metal pipes and beams, as well as a sizable amount of heavy construction equipment such as cranes and welding equipment. Most fabrication yards have large open spaces for jacket assembly as well as a number of covered warehouses and shops for storing materials and for supporting operations in inclement weather. The principle materials and supplies used in the fabrication business are standard steel shapes, steel plate, welding gases, fuel oil, gasoline, coatings, and paints. Like other industrial construction-oriented industries, the platform fabrication industry is vulnerable to primary commodity price increases with increases in both steel delivery times and price per ton.

The number of employees at fabrication yards may vary from less than a hundred to several thousand, and due to the project-oriented nature of work, temporary and contract workers account for a significant portion of the fabrication yard workforce. Industry employment trends can be seasonal as well as cyclical and can be very dependent upon large orders. The typical platform fabrication workforce can vary during the year with increases and decreases in contract labor depending upon the jobs in progress and backlog.

The location of platform fabrication yards is tied to the availability of a navigable channel sufficiently large enough to allow the towing of bulky and long structures, such as offshore drilling and production platforms. Thus, platform fabrication yards are located either directly along the Gulf Coast or inland, along large navigable channels, such as the Intracoastal Waterway. These waterways, which facilitate or limit movement into and out of the yard, can impact the size and scope of various projects that can be developed at a given location. Despite a large number of platform fabrication yards along the Gulf Coast, only a few facilities can handle large-scale fabrication. High capital costs restrict many companies from becoming full-service offshore construction companies, so many simply specialize in certain types of activities. Therefore, these smaller, more specialized fabrication yards work almost exclusively as subcontractors for competitors on larger jobs.

Figures 4-22 and 4-46 show the geographic distribution of platform fabrication yards across the CPA analysis area. There are 37 platform fabrication yards in Louisiana, mainly concentrated in Jefferson, Terrebonne, and Iberia Parishes. The remainder of the CPA analysis area only has five platform fabrication yards: four in Mississippi and one in Alabama.

Shipbuilding and Shipyards

There are several kinds of shipyards throughout the Gulf Coast region that build and repair all manner of vessels, many of which are not related to OCS activities. Generally, the shipbuilding and repair industry encompasses the sector responsible for building ships, barges and other large vessels, whether self-propelled or towed by other craft. These marine vessels are perhaps the most important means of transporting equipment and personnel from onshore bases and ports to offshore drilling and production structures. Facilities dedicated to constructing and repairing these various types of marine vessels also receive orders for marine vessels and ship repairs from a wide range of industries that can include commercial shipping companies, passenger and cruise companies, ferry companies, petrochemical companies, commercial fishing companies, and towing and tugboat companies. The primary vessels that shipbuilding yards provide to the oil and gas industry are known as “offshore service vessels” (OSV’s). These vessels transport a wide range of personnel and equipment ranging from pipes to wrenches to computers, fuel, and drinking water.

Shipyards are often categorized into a few basic subdivisions characterizing either the type of operation (shipbuilding or ship repairing), the type of ship (commercial or military), or the shipbuilding or repairing capacity of the vessels being constructed or repaired (first-tier or second-tier). Ships themselves are often classified by their basic dimensions, weight (displacement), load-carrying capacity (deadweight), or their intended service. Shipbuilding activities in the U.S., and particularly along the GOM, can vary considerably depending upon the primary markets these shipyards serve (i.e., commercial or military). In the CPA, the vast majority of shipyards are located in Louisiana (64), followed by Alabama (18), Florida (14), and Mississippi (9). **Figures 4-22 and 4-46** show the geographic distribution of shipyards across the CPA analysis area.

Like platform fabrication, almost all shipyard facilities lack the capability to construct or repair vessels under cover; most of the shipbuilding and repair work is done outdoors and near some major body of water such as a river or deep channel. For the most part, shipyards are designed to facilitate the flow of materials and assemblies. Like platform fabrication yards, growth and expansion of the facility is piecemeal and depends on technology and the availability of land and waterfront property.

In addition to construction, shipyards also conduct repairs. For some, a large quantity of their business comes from servicing OSV’s, the boats that work solely to provide services to the offshore oil and gas industry. The OSV’s primarily serve exploratory and developmental drilling rigs and production facilities, and support offshore and subsea maintenance activities. Besides transporting deck cargo, OSV’s also transport liquid mud, potable and drilling water, diesel fuel, dry bulk cement and personnel between shore bases and offshore rigs and facilities. **Chapter 4.2.1.23.1.1** discusses OSV’s in detail.

While the Gulf Coast shipbuilding region covers an area between south Texas and the tip of Florida, most shipbuilding facilities are concentrated in a 200-mi (322-km) area between New Orleans and Mobile. Condensed within this 200-mi (322-km) region, companies benefit from this close proximity, known as "clusters," in that it allows them to optimize construction and repair synergies. Major shipyards in the analysis area include Bollinger Shipyards, Harrison Brothers Dry Dock & Repair Yard, Inc., Edison Chouest Offshore, Northrop Grumman Corporation, and Bender Shipbuilding and Repair Company.

The U.S. Government and the shipbuilding industry have made great strides in their efforts towards industry revitalization and market transformation. In 1994, the Maritime Administration established the National Maritime Resource and Education Center to assist in increasing U.S. shipbuilding competitiveness. While recent activity has increased somewhat, new shipbuilding activity today is a very small fraction of the level of effort observed in the late 1970's. One major stimulus for shipbuilding activity has been increased deepwater oil and gas activity following the passage of the Deep Water Royalty Relief Act of 1995.

Although there are large investments in an effort to increase the competitiveness of American shipbuilders, one constant problem is the loss of many thousands of workers within the industry. Historically, turnover rates at shipyards have been high relative to other industries. Production work in the shipyard industry tends to be difficult, i.e., working conditions are outside and workers are therefore exposed to uncomfortable environmental conditions that usually arise in coastal zones (i.e., high heat, humidity). These negative work environment conditions continue to exist and, coupled with a low-skilled worker pool, have resulted in continued high turnover rates for the industry. To combat the lack of skilled labor, many shipyards have subcontracted work normally done within their own yards. However, technological innovation, through active research and development activities, can be an important substitute for shortages of skilled resources, particularly labor.

Pipecoating Plants and Yards

Pipecoating plants generally do not manufacture or supply pipe. They receive the manufactured pipe by rail or water at either their plant or pipe yard depending on their inventory capabilities. At the plant, pipes that transport oil and gas are coated on the exterior with metallic, inorganic, and organic materials to protect from corrosion and abrasion. Pipes may also be coated on the inside to protect against corrosion from the fluids being transported or to improve the flow. In addition to corrosion protection, many pipes that will be used offshore are also coated with a layer of concrete to increase the weight of the line to ensure it stays on the seabed.

Significant threats to pipeline integrity often include third-party damage, geological activity, and corrosion. The most common threat, external corrosion, is recognized as the main deterioration mechanism that can reduce the structural integrity of buried pipelines. In fact, corrosion ranks only second to human error as a cause of pipeline failure. Because coatings are the first line of defense in protecting pipelines against corrosion, they must be well bonded, continuous, and resist the effects of their environments. Pipe coating has emerged as an industry because it is a cost-effective means of extending the life of a pipeline.

Pipeline corrosion coating can be applied either before the pipe is delivered (yard applied) or after the pipe lengths are welded together and suspended above the trench. When pipe lengths are coated and wrapped at a coating yard before being delivered to the job site, a short distance at each end of each length of pipe is left bare so the joints can be welded together. When field welding is complete, coating and wrapping material is applied to the bare pipe sections. Pipecoating yards store 40-ft (12-m) segments of coated pipe until it is needed offshore. It is transported by barge to offshore locations for laying.

The levels of activity experienced by pipecoating companies depend on the requirement for new pipeline infrastructure, which is driven by investment in energy supply. The strongest trends in energy supply that affect demand are energy prices, world economic growth, advances in technologies, and future public policy decisions. Much of the pipe coating that takes place is done by companies that also produce the pipes themselves. If the coating company is a separate entity, it is often located near a pipe facility.

In the BOEM-defined EIA's, there are 19 OCS-related pipe coating companies. In Louisiana, there are six pipecoating facilities, mainly in Iberia Parish. The remaining CPA locations in the GOM region include Alabama (2 facilities) and Florida (2 facilities). To meet deepwater demand, pipecoating companies have been expanding capacity or building new plants. Major pipecoating companies in the

CPA analysis area are The Bayou Companies and Bayou Flow Technologies in New Iberia, Louisiana; Consolidated Piping and Supply in Birmingham, Alabama; and EB Pipe Coating and Midwestern in Panama City, Florida. Many pipecoating plants also handle pipe for non-OCS companies, other countries, and non-petroleum-related industries.

The pipecoating industry is labor intensive. The coatings are mostly applied by hand. The companies try to maintain a core base of laborers, then either scale up or down with temporary labor according to workload. Because of the cyclical nature of the business, maintaining labor is a problem for the industry. In addition, pipecoating companies compete with other infrastructure industries for welders. In order to reduce this problem, several companies have started welding training programs.

The pipe coating industry is dependent on the oil and gas market. Pipe coatings have evolved from simple coal-tar applications to more sophisticated fusion-bonded epoxies and polypropylene coatings. Companies continue to try new, cost-effective methods and materials in the battle against corrosion and extreme environmental effects. Sometimes the new methods involve using multiple types or layers of protection, and at other times, innovative processes use new materials. The advantages and disadvantages, particularly costs, of each type of coating needs to be taken into account in the development of different coating products.

During the 1980's, the coatings business experienced significant growth. The 1990's saw additional change with a push for companies to research new products for growing deepwater GOM exploration activities. As the oil and gas industry moves to deeper water exploration, the pipecoating industry has to remain dynamic to changing needs.

With increases in natural gas demand and promising developments in the Gulf of Mexico, transmission capacity will also need to expand, and thus the need for pipeline coatings increases. In turn, pipeline coating companies have increased output to meet the increased demand for services.

Service Bases and Waste Disposal Facilities

Unless otherwise indicated, the following information is from BOEM's three OCS Gulf of Mexico Fact Books: (1) *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (The Louis Berger Group, Inc., 2004); (2) *Fact Book: Offshore Oil and Gas Industry Support Sectors* (Dismukes, 2010); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, 2011b). The major support facilities discussed in the following section include service bases/ports, waste disposal facilities, and natural gas storage.

Service Bases/Ports

A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel that are needed at offshore work sites. A service base may also be referred to as a supply base and may be associated with a port. Although a service base may primarily serve the OCS planning area and the EIA in which it is located, it may also provide significant services for the other OCS planning areas and EIA's. A CPA proposed action is not projected to change existing OCS-related service bases or require construction of new service bases. Instead, it would contribute to the use of existing service bases. **Figure 4-24** shows the primary service bases the industry currently uses to service the OCS. These facilities are identified from exploration and development plans received by BOEM. **Table 3-15** lists the OCS-related services bases according to EIA. The ports of Fourchon, Cameron, Venice, and Morgan City, Louisiana, are the primary service bases for Gulf of Mexico mobile rigs. Other major platform service bases in the CPA include Intracoastal City, Louisiana; Pascagoula, Mississippi; and Mobile, Alabama.

This extensive network of supply ports includes a wide variety of shore-side operations from intermodal transfer to manufacturing. Their distinguishing features show great variation in size, ownership, and functional characteristics. Basically, two types of ports provide this supply base. Private ports operate as dedicated terminals to support the operation of an individual company. They often integrate both fabrication and offshore transport into their activities. Public ports lease space to individual business ventures and derive benefit through leases, fees charged, and jobs created. These benefits spread throughout the entire area and are viewed as economic development impacts. Thus, the public ports play a dual role by functioning as offshore supply points and as industrial or economic development districts.

An efficient network of ports lowers costs associated with oil and gas production and significantly boosts the well-being of citizens of the adjacent communities.

The significant prosperity that has followed the industry has resulted in issues and concerns that must be addressed at the local community level. For example, additional commercial traffic associated with offshore supplies has caused worsening road conditions at Port Fourchon. While local governments near the service bases have gained revenue from the increased activity within their jurisdictions, the demands for additional services and facilities resulting from oil and gas operations have sometimes exceeded growth in the revenue stream. Local tax dollars cannot meet the many demands for improvements when they are needed in short timeframes. State and Federal matching funds are sought where possible, but the acquisition of those funds often has built-in delaying factors. Nevertheless, communities are attempting to meet the demands of the offshore industry. Thus, the oil and gas industry is determining the direction and scope of improvements being made at local levels. Communities, just like the ports, must be able to anticipate future demands for their services. In order to plan for this growth, communities need timely information about trends in the industry.

Rapidly developing offshore technology has placed an additional burden on service-base ports. As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range of travel, greater speed of travel, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: a strong and reliable transportation system; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; a location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership.

Service bases are utilized for three types of OCS offshore support: supply vessel, crewboat, and helicopters, which are described in detail below (**Chapters 3.1.1.8.4 and 3.1.1.8.5**). Supply vessels transport pipe and bulk supplies, and the supply vessel base serves as the loading point and provides temporary storage. Crewboats transport personnel and small supplies. Collectively, supply vessels and crewboats are known as OSV's. The high demand for OSV's translates into a positive impact on OCS-related employment. Helicopters transport small supplies and workers, and they also may patrol pipelines to spot signs of damage or leakage.

Several new trends along the GOM have resulted in changing needs for the offshore and maritime industry. This, in turn, has placed a burden on OCS ports to provide the necessary infrastructure and support facilities in a timely manner to meet growing industry needs. Important energy trends that have developed over the last decade are as follows:

(1) changing exploration and production technology from one based on fixed structures, to one more commonly based on a variety of floating/ship-based type of structures;

(2) increasing deepwater and ultra-deepwater drilling;

(3) changes in OSV specifications (i.e., bigger and deeper);

(4) climate change, storm events, and other environmental concerns (i.e. water usage, changing regulations on emissions such NO_x, SO_2, and ozone requirements);

(5) global competition;

(6) changes in energy prices; and

(7) LNG development.

Increased port activity creates economic benefits in the form of increased employment, economic output, and other value-added benefits such as tax revenue, fees, and royalties. The amount of goods and services transferred at ports has increased over the past decade including materials directly related to offshore oil and gas exploration and production, including increasing equipment, drilling fluids, structures, supplies, and crew transfers. The increase of LNG imports through the GOM also has the potential to increase the demand for goods and services located at ports such as tub and barge services.

As the oil and gas industry has thrived in the GOM, the need increases for a logistical support system that links all phases of the operation and extends beyond the local community. Service bases serve as the hub for intermodal linkages between land-based supply and fabrication centers that provide the equipment, personnel, and supplies to offshore facilities. The necessary onshore support segment includes inland transportation to supply bases, equipment manufacturing, and fabrication. The offshore support involves both waterborne and airborne transportation modes. **Chapter 3.1.1.8** addresses the transportation of personnel, supplies and production between offshore and onshore locations.

Waste Disposal Facilities

A variety of different types of wastes are generated by offshore oil and gas exploration and production activities along the GOM. Some wastes are common to any manufacturing or industrial operation (e.g., garbage, sanitary waste [toilets] and domestic waste [sinks and showers]), while others are unique to the oil and gas industry (e.g., drill fluids and produced water). Most waste must be transported to shore-based facilities for storage and disposal. The different physical and chemical characters of these wastes make certain management methods preferable over others. The different types of waste generated as a result of offshore exploration and production activity include

- solids, such as drill cuttings, pipe scale, produced sand, and other solid sediments encountered during drilling, completion, and production phases;
- drilling muds, either oil-based, synthetic, or water-based;
- aqueous fluids having relatively little solids content, such as produced waters, waters separated from a drilling mud system, clear brine completion fluids, acids used in stimulation activities, and wash waters from drilling and production operations;
- naturally occurring radioactive materials (NORM), such as tank bottoms, pipe scale, and other sediments that contain naturally high levels of radioactive materials;
- industrial hazardous wastes, such as solvents and certain compounds with chemical characteristics that render them hazardous under Subtitle C of the Resource Conservation and Recovery Act and thus not subject to the exemption applicable to wastes generated in the drilling, production, and exploration phases of oil and gas activities;
- nonhazardous industrial oily waste streams generated by machinery operations and maintenance, such as used compressor oils, diesel fuel, and lubricating oils, as well as pipeline testing and pigging fluids; and
- municipal solid waste generated by the industry's personnel on offshore rigs, platforms, tankers, and workboats.

The infrastructure network needed to manage the spectrum of waste generated by OCS exploration and production activities and returned to land for management can be divided into three categories:

(1) transfer facilities at ports, where the waste is transferred from supply boats to another transportation mode, either barge or truck, toward a final point of disposition;

(2) special-purpose, oil-field waste management facilities, which are dedicated to handling particular types of oil-field waste; and

(3) generic waste management facilities, which receive waste from a broad spectrum of American industry, of which waste generated in the oil field is only a small part.

The first two categories lend themselves to a capacity analysis while the third does not. **Table 3-13** shows the waste disposal facilities in the analysis area by state. There are three each in Mississippi and Alabama and two in Florida. The bulk of OCS-related waste disposal facilities (nearly 85%) are located in Texas and Louisiana. Louisiana (29) supports nearly twice as many as Texas (16). **Figures 4-22 and 4-46** show the geographic distribution of waste disposal facilities across the CPA analysis area.

The capacity of a waste facility has two dimensions. The first is the throughput capacity over a given period of time. In the short term, a waste facility can face limits to the volume of waste it accepts either from permit conditions or from physical limitations to the site, such as unloading bays, traffic conditions, or equipment capacity. Life-of-site capacity is also a limiting factor for disposal facilities. Limitations of storage space or, in the case of an injection well, service life of the well make it necessary to consider what must happen after existing facilities have exhausted their capacity.

Federal regulations govern what may be discharged in GOM waters and set different standards in different parts of the Gulf Coast. State regulations governing reporting and manifesting requirements may vary somewhat, but Federal law has, for the most part, preempted the field of waste transportation regulation. Dockside facilities that serve as transfer points from water to land modes of transportation are regulated by both USCG and State regulations covering the management of oil-field wastes.

Once at a waste management facility, regulations regarding storage, processing, and disposal vary depending on the type of waste. Most would fall under the oil and gas waste exemption of Subtitle C of the Resource Conservation and Recovery Act and would be subject only to State regulations regarding the disposal of oil-field wastes. State laws governing hazardous wastes are allowed to be more restrictive than Federal law, but no material differences exist between State and Federal law in Texas, Louisiana, Mississippi, or Alabama. For the most part, the wastes generated by oil-field activities, called nonhazardous oil-field waste (NOW) are exempt from hazardous waste regulation by Federal law because they are produced from the exploration, development, or production of hydrocarbons and thus fall under what is generally referred to as the oil and gas waste exemption found in 40 CFR 261.

Waste fluids and solids containing NORM are subject to State regulations that require special handling and disposal techniques. There are currently no Federal regulations governing NORM. The States' special handling and disposal requirements for NORM generally result in the segregation of these materials from NOW and in substantially higher disposal costs when managed by commercial disposal firms.

The USEPA has established a hierarchy of waste management methods that it deems preferentially protective of the environment. For those technologies applicable to oil and gas production waste, the following general waste management techniques are described in order of USEPA's preference:

- *Recycle/Reuse*—When usable components such as oil or drilling mud can be recovered from a waste, these components are not discarded and do not burden the environment with impacts from either manufacturing or disposal.
- *Treatment/Detoxification*—When a waste cannot be recycled or reused, it can sometimes be treated to remove or detoxify a particular constituent prior to disposal. Neutralization of pH or the removal of sulfides are examples of technologies that are used with oil and gas wastes.
- *Thermal Treatment/Incineration*—Wastes with organic content can be burned, resulting in a relatively small amount of residual ash that is incorporated into a product or sent to disposal. This technology results in air emissions, but the residuals are generally free of organic constituents.
- *Subsurface Land Disposal*—This technology places waste below usable drinking water resources and is viewed as superior to landfilling because of the low potential for waste migration. Injection wells and salt cavern disposal are examples of this type of technology.
- *Surface Land Disposal/Treatment*—This type of technology involves the placement of wastes into a landfill or onto a land farm. Although well-designed and constructed landfills minimize the potential for waste migration, generators remain concerned about migration of contaminants into water resources and avoid it whenever practical. The USEPA classifies surface land disposal as the least desirable disposal method.

Several waste management methods are used to handle the spectrum of wastes generated by OCS activity, and most types of wastes lend themselves to more than one method of management. Each option has a different set of environmental impacts, regulatory constraints, costs, and capacity limitations. The most common waste management methods are recycling of drilling wastes, offshore marine discharge, subsurface injection, salt cavern disposal, land application, and landfilling.

Most water-based muds (WBM) are disposed of at the conclusion of a drilling job. Oil-based muds (OBM) and certain synthetic-based muds (SBM) can be recycled when possible. Sometimes the physical and chemical properties of the used muds degrade, limiting their ability to be recycled necessitating some different type of reuse or disposal. The left-over cuttings from drilling operations can be used to stabilize surfaces like roads or drilling pads. Oily cuttings can serve as a substitute for traditional tar-and-chip road surfacing; however, not all regulatory agencies will allow the use of these leftovers. Some jurisdictions limit road spreading to dirt roads on onshore oil and gas leases, while others may allow cuttings to be spread on a limited basis on public dirt roads. Operators must obtain prior permission from the regulatory agency, as well as the private landowner, before spreading cuttings. Operators are typically required to ensure that cuttings are not spread close to stream crossings or on steep slopes. Application rates should be controlled so that no free oil appears on the road surface.

Offshore marine discharges have become more and more restricted over the years. In the late 1970's, USEPA first began restricting ocean discharges of drilling muds and cuttings through NPDES permits. In 2001, USEPA, DOE, BOEM, and numerous companies and industry associations collaborated to finalize new effluent limitations guidelines for SBM's.

Subsurface injection is the management method used for more than 90 percent of the 16 billion barrels of saltwater produced by onshore oil and gas production each year in the U.S. An injection well can best be envisioned as a producing well operating in reverse, with very similar drilling and completion procedures. In fact, depleted producing wells are sometimes converted to injection wells. Salt caverns, utilized for a variety of underground storage purposes, are created by a process called solution mining. Wastes are transported to the cavern site in trucks and unloaded into mixing tanks, where they are blended with water or brine to make slurry. The exploration and production wastes that are suitable for disposal in caverns include drilling muds, drill cuttings, produced sands, tank bottoms, contaminated soil, and completion and stimulation wastes. Drilling muds, produced sand, and other fine solids are candidates for land application, often called land farming. Land farming can be a relatively low-cost approach to managing offshore drilling wastes. Under the land farming disposal method, muds and other solids are spread on land and mixed with earth to be incorporated into the soil, or they are deposited into dedicated pits. This is a common form of waste disposal across the GOM. Studies indicate that land farming does not adversely affect soils and may even benefit certain sandy soils by increasing their water-retaining capacity and reducing fertilizer losses. Land farming regulations along the GOM depend on site-specific permits except for onsite disposal of onshore drilling waste. Land farming carries a risk of long-term liability from either leakage or liability from use of the recycled material. While any method has its risks, land farming is perceived as riskier than underground injection methods.

Landfilling occurs at an engineered landfill facility with protective liners and caps to isolate the waste from the larger environment. Municipal solid waste is placed in an excavated cell, usually lined with high-density polyethylene to prevent leakage into the groundwater. The municipal solid waste must be covered daily to control odors, birds, and vermin brought about by rotting food wastes. Drilling muds and wastewater streams that have been solidified can be used as a daily cover. Use of this type of material often improves a site's soil balance, meaning the volume of soil required over the life of the landfill for its construction and operation will be less than it would be if these materials were not available and other soils had to be hauled in at a cost.

The waste disposal industry is also highly dependent upon environmental laws and regulation. The more stringent the regulations, the more demand for waste services as exploration and production companies take steps to comply with the more stringent regulations. Conversely, the industry could be adversely affected by new regulations or changes in current regulations. At present, oil-field waste that is not contaminated with NORM is exempt from the principle Federal statute governing the handling of hazardous waste. However, in recent years, proposals have been made to retract this exemption.

In early 2010, the Louisiana Dept. of Environmental Quality announced a pilot program to allow exploration and production waste to be disposed of at three Type I landfills that handle industrial solid waste: Riverbirch and CWI-White Oaks in Jefferson Parish and LaSalle/Grant in LaSalle Parish. Previously, there were no Louisiana landfills allowed to accept exploration and production waste. However, all landfills that accept industrial waste in Louisiana have liners, groundwater monitoring systems and leachate collection systems; therefore, the risk is considered minimal. The decision was based on the increased oil and gas production in Louisiana, the environmental regulations already in place for these landfills, and their close proximity (Louisiana Dept. of Environmental Quality, 2010).

Natural Gas Storage Facilities

Natural gas storage serves two primary functions: to meet seasonal demands for gas (base-load storage) and to meet short-term peaks in demand (peaking storage). Peaks in natural gas demand can range from a few hours to a few days. To ensure that adequate natural gas supplies are available to meet seasonal base-load customer requirements, underground natural gas storage facilities are filled during low utilization periods in what is commonly called the "injection season," typically between April through October of any given year. Natural gas that is placed into storage is ultimately moved to markets to supplement domestic production and imports during what is referred to as the "withdrawal season" between the fall/winter peak usage months of November to March. The benefit of using storage instead of expensive pipeline capacity is passed along to customers through lower rates and more reliable service.

There are three main types of underground natural gas storage facilities: depleted reservoirs in oil and/or gas fields; aquifers; and salt cavern formations. Each type of storage facility has its own physical characteristics that include porosity, permeability, and retention capability. Each type of storage facility also has its own economic characteristics that include capacity development costs, location, deliverability rates, and cycling capability.

Most of the natural gas storage facilities in the Gulf region are salt caverns. Salt caverns have certain cost benefits since they have lower base or "cushion gas" requirements than reservoirs and aquifers. Cushion gas is the term used to describe the minimum amount of gas that is needed in an underground storage facility to maintain operating pressures and in the case of salt, maintain cavern integrity. In today's markets, facilities that have large cushion gas requirements can be more expensive since they tie up large amounts of highly valued gas in limited-revenue generating activities. Thus, salt has an advantage relative to other types of underground storage since it typically requires considerably less cushion gas. However, salt's advantage over reservoir storage has to be balanced against its increased initial capital development cost. Reservoir storage is much cheaper on a capacity-developed basis.

Depleted reservoirs are simply geological formations that have stopped economic production of natural gas. These formations make excellent storage facilities since they are typically developed from known formations with a natural gas production history. In addition, quite often, these formations will have surface facilities on site that can be used or converted to gas storage service. According to industry reports, depleted reservoirs tend to be the most economic of the three main storage types both in development and operation (NaturalGas.org, 2011).

The Gulf Coast has a mix of depleted reservoir and salt cavern storage. In fact, the overwhelming majority of all salt cavern storage facilities operating in the U.S. are located along the GOM. Gulf Coast salt caverns account for only 4.2 percent of total U.S. working gas capacity and 15.5 percent of total U.S. deliverability. In the GOM, Louisiana has seven salt cavern sites with 48 Bcf of working gas capacity, Mississippi has three sites with 32 Bcf of working gas capacity, and Alabama has one site with 7 Bcf of working gas capacity (USDOE, Energy Information Administration, 2007). Not all of these facilities are located within the BOEM-defined EIA's. More specifically, there are 22 underground natural gas storage facilities in the BOEM-defined EIA's. These facilities total 372 Bcf of working gas capacity. **Figures 4-22 and 4-46** show the geographic distribution of natural gas storage facilities across the CPA analysis area.

Transportation

The major forms of OCS crew, supply, and product transportation discussed in the following section include: heliports; OCS support vessels; coastal pipelines/pipeline landfalls/pipeline shore facilities; and coastal barging/barge terminals. As the oil and gas industry continues to evolve so do the requirements of the onshore support network. With advancements in technology, the shoreside supply network continues to be challenged to meet the needs and requirements of the industry. All crew and supplies must be transported between land-based facilities to marine vessels or helicopters and offshore destinations. Likewise, all offshore oil and gas production must be transported onshore in some manner, whether by pipeline or tanker.

Heliports

Unless otherwise indicated, the following information is from BOEM's three OCS Gulf of Mexico Fact Books: (1) *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (The Louis Berger Group, Inc., 2004); (2) *Fact Book: Offshore Oil and Gas Industry Support Sectors* (Dismukes, 2010); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, 2011b).

Heliports are centralized locations where helicopters disembark for offshore service. Helicopters move crew and equipment to offshore areas and serve as one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. While supply boats are typically used for short-haul service, helicopters are the primary means of transportation for longer distances as well as instances when speed of delivery (equipment and personnel) may be pressing. In addition, equipment and supplies are sometimes transported. For small parts needed for an emergency repair or for a costly piece of equipment, it is more economical to get it to and from offshore fast rather than by supply boat. For example, the Bell 206L Long Ranger has a fuel capacity of 110 gallons and can travel up to 320 nmi (368 mi; 593 km). Its cruising speed at sea level is about 130 knots (150 mph). This would include most deepwater platforms and facilities in the GOM. A supply boat (specifically a crew boat for transporting personnel), on the other hand, has a cruising speed of 20-35 knots (23-40 mph).

Heliport service providers usually retain a mix of size and quantity of aircraft, with their fleets categorized into small, medium, and large helicopters. The small helicopters are better suited for support of production management activities, daytime flights, and shorter routes. Many of the shallow-water production facilities in the GOM are too small to accommodate anything larger than a small helicopter, making the GOM a strong market for this group of helicopters. Medium helicopters are the most versatile part of an air transportation company's fleet because they are equipped to fly in a variety of operation conditions, are capable of flying longer distances, and can carry larger payloads than small helicopters. Large helicopters are also able to fly in a variety of different operations, but they can also perform in harsh weather conditions, carry larger payloads, fly longer distances, and hold up to 25 passengers. Medium and large helicopters are most commonly used for crew changes on large offshore production facilities and drilling rigs.

This industry is largely dependent on the level of production, development, and exploration in the Gulf. The demand for helicopters increases with an increase in activity levels associated with oil and gas production; however, as oil and gas companies seek to reduce costs with respect to air transportation services, the demand for the frequency of these services is reduced. Greater total (and relative) deepwater activities in the GOM are forcing significant changes on the transportation industry in the region. For example, the helicopter and vessel industries must have the capability of traversing longer distances with more cargoes that were necessary even a decade ago.

Most service providers maintain a mix of small-, medium-, and large-sized aircrafts to meet the diverse needs of the offshore industry. A few people making a short, daytime trip in good weather to a small production site would need only a small helicopter carrying 4-7 passengers, whereas shift change crews, trips to distant locations, bad weather, international markets, or large loads would require the use a medium-sized craft carrying up to 13 passengers or even larger ones holding up to 25 passengers. As production activity moves ever farther offshore into the deepwater of the Gulf of Mexico, the need for medium and large helicopters will continue.

Industry consolidation has resulted in a small number of large helicopter service providers. The Gulf is served primarily by three large operators: Bristow Group (formerly Offshore Logistics); PHI, Inc. (formerly Petroleum Helicopters, Inc.); and Seacor (formerly ERA Aviation). These top three providers account for nearly 80 percent of the aircraft available in the Gulf. **Figure 4-24** shows the locations of the major helicopter service providers. Other competitors in this region are smaller, privately-owned entities or subsidiaries of larger companies. These companies include Evergreen, Houston Helicopters, and Rotorcraft Technologies. **Table 3-13** shows the distribution of helicopter hubs across the Gulf Coast States. In the WPA, there are 118 OCS-related heliports in Texas and 115 in Louisiana, which mirrors the distribution of infrastructure in the GOM region where the majority of activity occurs in Louisiana and Texas, with a lesser concentration in Mississippi. In the CPA, there are 115 OCS-related heliports across southern Louisiana. Mississippi and Alabama only host four helicopter hubs each. There are no actively utilized OCS-related heliports in Florida, but the infrastructure exists should the EPA be opened up in the future.

OCS Support Vessels

Unless otherwise indicated, the following information is from BOEM's three OCS Gulf of Mexico Fact Books: (1) *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (The Louis Berger Group, Inc., 2004); (2) *Fact Book: Offshore Oil and Gas Industry Support Sectors* (Dismukes, 2010); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, 2011b).

The primary types of OCS support vessels include anchor handling, towing and supply vessel (AHTS), offshore supply vessels (OSV's) and their larger cousins, the marine platform supply vessels (PSV's), as well as crew boats and their related fast support vessels (FSV's). These vessels work solely to provide services to the offshore oil and gas industry, serving primarily exploratory and developmental drilling rigs and production facilities, and to support offshore and subsea maintenance activities. In addition to transporting deck cargo, most of these also transport liquid mud, potable and drilling water, diesel fuel, dry bulk cement and personnel between shore bases and offshore rigs and facilities. A new type of vessel that will start working in the GOM is the FPSO, mentioned briefly in the platform fabrication section above.

The AHTS vessels tow rigs to their locations and come equipped with powerful winches to lift and position the rig's anchors. Some AHTS vessels can carry small amounts of supplies, such as drill pipe or drilling fluid, while others are limited to carrying rigs and rig anchors. Most newer, deepwater AHTS vessels are equipped with stronger winches, dynamic positioning capability, and more room to transport supplies (Barrett, 2008).

The OSV's, and PSV's deliver drilling supplies such as liquid mud, dry bulk cement, fuel, drinking water, drill pipe, casing, and a variety of other supplies to drilling rigs and platforms. The majority of OSV's in service are old, legacy boats built during the boom in the late 1970's/early 1980's. A typical boat from that era is about 180 ft (55m) long and can carry about 1200 bbl of liquid mud and about 1,000 tons (dead weight tons) of deck cargo. New generation OSV's are between 220 and 295 ft (67 and 90 m) long and can carry 3-10 times as much liquid mud and 2-4 times as much deck cargo. New generation supply boats can haul about three to ten times more liquid mud, two to four times as much deck cargo and come equipped with global positioning systems and multiple thrusters to correctly position the boat (Barrett, 2008).

Crew boats transport personnel to, from, and between offshore rigs and platforms. These boats are much smaller than the AHTS vessels or OSV's and can range in size from 75 to 190 ft. (23m-58m). They are classified by cruising speed and the smaller ones are used to transport crews between offshore platforms rather than to and from shore. The FSV's can transport crews swiftly, but are only able to carry a limited amount of supplies (Barrett, 2008).

The FPSO's consist of a floating tank system designed to process and store all of the oil or gas produced from a nearby deepwater platform until it can be offloaded into tankers or transported through pipelines. The FPSO's, while new to the GOM, are used extensively in other countries as an alternative to installing expensive pipelines.

The other less familiar OCS support vessels include the following:

- *Utility/Workboats* – support offshore construction projects and workovers;
- *Survey Vessels* – collect geophysical data;
- *Well Stimulation Vessels* – perform fracturing and acidizing of producing wells; and
- *Multi-Purpose Supply Vessels* – several uses include remote subsea intervention services, remotely operated vehicle operations, firefighting, oil-spill recovery, deepwater lifting and installation, and supply delivery (Barrett, 2008).

The GOM has long been one of the busiest supply-boat markets in the world, a direct result of the historical level of oil-field activity that has taken place in the region. The market is highly competitive, and it is estimated that there are over 150 different boat owners operating over 850 boats in the GOM. Tidewater is the dominant company and is the largest supply boat company in the world; however, it has an aging fleet that is losing more and more business to new, next generation vessels.

The supply boat industry is volatile and subject to a high level of operating leverage. Activity level changes can be dramatic and can have an adverse or positive effect on profits, depending on which way they are cycling. This is because about 70 percent of daily cash operating costs are fixed; therefore, when activity is high, profitability goes up, when activity is low, the converse is true. Boat owners in the GOM typically use the spot market to win work rather than using long-term contracts, meaning that the job only lasts as long as the task at hand. The day rate for vessels depend on multiple factors such as contract length, boat type, boat location and especially the supply/demand balance at the time of contract negotiations. Rates may range from $2,000/day for a crew boat in rough economic times, to $40,000/day for an AHTS vessel at the peak of an economic cycle (Barrett, 2008).

Coastal Pipelines/Pipeline Landfalls/Pipeline Shore Facilities

A mature pipeline network exists in the GOM to transport oil and gas production from the OCS to shore. Almost the entirety of Federal OCS production is transported to shore via pipelines, with the exception of a small amount from shallow water that is barged to shore. Most new OCS pipelines connect to existing pipelines offshore. In recent decades, there has been a steady decline in the number of new pipeline construction projects that result in new pipeline landfalls (USDOI, MMS, 2007a). About 250 of the active OCS pipelines cross the Federal/State boundary into State waters. There are nearly 1,900 km (1,181 mi) of OCS pipelines in State waters. Over half of the pipelines in State waters are directly the result of the OCS Program.

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Gulfwide, about 60 percent of OCS pipelines entering State waters tie into existing pipeline systems and do not result in new pipeline landfalls. About 90 percent of OCS pipeline landfalls are in Louisiana (USDOI, MMS, 2007a). The oldest pipeline systems are also in Louisiana; some date back to the 1950's. There are over 100 active OCS pipelines making landfall, resulting in 200 km (124 mi) of pipelines onshore, with an average of 2 km (1 mi) per pipeline. About 80 percent of the onshore length of OCS pipelines is in Louisiana with the longest resulting in 50 km (31 mi). A small percentage of onshore pipelines in the EIA's are directly the result of the OCS Program.

The busiest decades for OCS pipeline landfall installations were the 1960's and 1970's, when 31 percent and 37 percent of all OCS pipeline landfalls were installed, respectively. As the OCS pipeline network became more established, the number of new Federal OCS pipeline landfalls decreased. Federal OCS pipeline landfalls installed in the 1980's accounted for 15 percent of all OCS pipeline landfalls installed to date, while the remaining 9 percent were installed in the 1990's, and 5 percent have been installed since 2000. Since the mid-1980's, the long-term trend is for new Federal OCS pipelines to tie into existing systems rather than creating new landfalls. Since 1986, the 5-year moving average of new Federal OCS pipeline landfalls has been below two per year. The last Federal OCS pipeline landfall was installed in 2005. Over the 10-year period, 1996-2005, there was an average of one new OCS pipeline landfall per year. During this same 10-year period, there were about 2,300 OCS pipelines installed. Of those, only 10 (0.4%) resulted in new pipeline landfalls. The remaining pipelines (99.6%) connected to the existing infrastructure in Federal or State waters (USDOI, MMS, 2007a). Since 2005, there have only been three new pipeline landfalls; all are located in Louisiana. **Table 3-16** shows all pipeline landfalls that have occurred since 1996 (USDOI, BOEMRE, 2011d). **Table 3-13** gives the numerical distribution of pipeline landfalls by state.

The BOEM analyzed the potential for new pipeline landfalls to determine the potential impacts to wetlands and other coastal habitats by analyzing past lease sale outcomes. This analysis shows that it is generally unlikely that even one landfall would result from an individual CPA lease sale. A mature pipeline network already exists in the Gulf of Mexico and companies have very strong financial incentives to reduce their costs by designing and utilizing pipeline systems to their fullest extent possible. Companies consider "economies of scale" in pipeline transportation, maximizing the amount of product moved through a constructed pipeline to decrease the long-run, average cost of production. Mitigation costs for any new wetland and environmental impacts, as well as various landowner issues at the landfall point, are additional considerations. These are strong incentives to move new production into existing systems and to avoid creating new landfalls (USDOI, MMS, 2007a). This analysis confirms BOEM's assumption that the majority of new pipelines constructed would connect to the existing infrastructure in Federal and State waters and that very few would result in new pipeline landfalls. However, there may be instances where new pipelines would need to be constructed. Location will be a determining factor; if there are no existing pipelines reasonably close and it is more cost effective to construct a pipeline to shore, then there may be a new OCS pipeline landfall. However, the very strong financial incentives to link into the existing, mature pipeline network make this highly unlikely (Dismukes, official communication, 2011a).

The term "pipeline shore facility" is a broad term describing the onshore location where the first stage of processing occurs for OCS pipelines carrying different combinations of oil, condensate, gas, and produced water. These facilities may also be referred to as a separation or field facilities. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to a gas processing plant (**Chapters 3.1.2.1.5.1 and 3.1.2.1.4.2**). Although in some cases some processing occurs offshore at the platform, only onshore facilities are addressed in this section.

Pipeline shore facilities may separate, process, pump, meter, and store oil, water, and gas depending on the quality of the resource carried by the pipeline. After processing and metering, the liquids are either piped or barged to refineries or storage facilities. The gas is piped to a gas processing plant for further refinement, if necessary; otherwise it is transported via transmission lines for distribution to commercial consumers. Water that has been separated out is usually disposed into onsite injection wells. A pipeline shore facility may support one or several pipelines. Typical facilities occupy 2-25 ha (5-62 ac).

Coastal Barging/Barge Terminals

There is a tremendous amount of barging that occurs in the coastal waters of the GOM, and no estimates exist of the volume that is attributable to the OCS industry. Secondary barging of OCS oil often occurs between terminals or from terminals to refineries. Oil that is piped to shore facilities and terminals is often subsequently transported by barge up rivers, through the Gulf Intracoastal Waterway, or along the coast.

Barges may be used offshore to transport oil and gas, supplies such as chemicals or drilling mud, or wastes between shore bases and offshore platforms. Barges are non-self-propelled vessels that must be accompanied by one or more tugs. Because of this, barge transport is usually constrained to shallow waters of the GOM, close to the shoreline.

Barging of OCS oil from platforms to shore terminals is an option used by the oil industry in lieu of transporting their product to shore via pipeline. A platform operator generally decides at the beginning of a development project whether the production will be barged or piped. Other types of barging operations may occur in connection with OCS operations. Besides barging from platform to shore terminal, a few platform operators choose to barge their oil to other platforms where it is then offloaded to storage tanks and later piped to shore. Barging is used very infrequently as an interim transport system prior to the installation of a pipeline system.

Barge terminals are the receiving stations where oil is first offloaded from barges transporting oil from OCS platforms. These facilities usually have some storage capabilities and processing facilities. Some barge terminals may also serve as pipeline shore facilities.

Because the volumes of oil reported to BOEM are determined at the offshore locations prior to barging, the final destination of the oil varies. Therefore, BOEM does not have an exact number of onshore terminals receiving OCS oil production. Several barge terminals located along the Gulf Coast receive State production or imports. Barged OCS production may be taken to any existing barge terminal. Historically, the OCS oil industry has used the following barge terminals in the CPA: Amelia, Lake Charles, Gibson, Calumet and Empire, Louisiana. These barge terminals may also receive oil from State production or imports. **Figures 4-22 and 4-46** illustrate the distribution of barge terminals across the CPA region. **Table 3-13** gives the numerical distribution of barge terminal facilities by state.

Processing Facilities

Unless otherwise indicated, the following information is from BOEM's 's three OCS Gulf of Mexico Fact Books: (1) *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (The Louis Berger Group, Inc., 2004); (2) *Fact Book: Offshore Oil and Gas Industry Support Sectors* (Dismukes, 2010); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, 2011b). The following section includes a description of gas processing plants, LNG terminals, refineries, and petrochemical plants.

Gas Processing Plants

Natural gas, as it is produced from a reservoir rock, is typically a mixture of light hydrocarbon gases, impurities, and liquid hydrocarbons. Natural gas processing removes the impurities and separates the light hydrocarbon mixture into its useful components.

The quality and quantity of components in natural gas varies widely by the field, reservoir, or location from which the natural gas is produced. Although there really is no "typical" make-up of natural gas, it is primarily composed of methane (the lightest hydrocarbon component) and ethane.

In general, there are four types of natural gas – wet, dry, sweet, and sour. Wet gas contains some of the heavier hydrocarbon molecules and water vapor. When the gas reaches the earth's surface, a certain amount of liquid is formed. The water has no value; however, the remaining portion of the wet gas may contain five or more gallons of recoverable hydrocarbons per thousand cubic feet. If the gas does not contain enough of the heavier hydrocarbon molecules to form a liquid at the surface, it is a dry gas. Sweet gas has very low concentrations of sulfur compounds, while sour gas contains excessive amounts of sulfur and an offensive odor. Sour gas can be harmful to breathe or even fatal.

All natural gas is processed in some manner to remove unwanted water vapor, solids, and/or other contaminants that would interfere with pipeline transportation or marketing of the gas. After raw gas is brought to the earth's surface, it is processed at a gas processing plant to remove impurities. Typical contaminants include water, H_2S, carbon dioxide, nitrogen, and helium. Centrally located to serve different fields, natural gas processing plants have two main purposes: (1) remove the impurities from the gas; and (2) separate the gas into its useful components for eventual distribution to consumers. After processing, gas is then moved into a pipeline system for transportation to an area where it is sold.

The natural gas processing business includes a wide range of company types, such as fully integrated oil companies, intrastate pipeline companies, major interstate pipeline companies and their nonregulated affiliates, and independent processors. Each company type has varying levels of financial and personnel resources. Competition in the market generally revolves around price, service, and location.

More than half (54%) of the natural gas processing plant capacity in the U.S. is located along the Gulf Coast and is available for supporting Federal offshore production (USDOE, Energy Information Administration, 2011d). Four of the largest capacity natural gas processing and treatment plants are found in Louisiana. **Figures 4-22 and 4-46** illustrate the distribution of gas processing plants across the CPA region. **Figure 4-25** provides a schematic of the natural gas supply chain. **Table 3-13** gives the numerical distribution of gas processing facilities by state.

There is great variability in efficiency and capacity across the gas processing industry. Some states have processing facilities with higher capacities than those in others. For instance, in 2009, Texas had 163 gas processing plants and Louisiana had only 60 gas processing plants; however, Louisiana's processing capacity was nearly as high, with less than half as many facilities (Louisiana, 18,535 MMcf/day; Texas, 19,740 MMcf/day). The states of the CPA (i.e., Louisiana, Mississippi, Alabama, and Florida) account for nearly 30 percent of the Nation's total processing capacity. Together Texas and Louisiana account for 49 percent of the natural gas processed in the United States (USDOE, Energy Information Administration, 2011d). Generally speaking, there has been a substantial decrease in offshore natural gas production, partially as a result of increasing emphasis on onshore shale gas development, which is less expensive to produce and provides larger per-well production opportunities and reserve growth. Also, there has been a trend toward more efficient gas processing facilities with greater processing capacities. In Alabama, Mississippi, and the eastern portion of south Louisiana, plant capacity increased significantly as plant expansions occurred and new larger plants were constructed in response to offshore production. The average capacity per plant in Mississippi doubled from 262 MMcf/day to 568 MMcf/day (USDOE, Energy Information Administration, 2011e).

While natural gas production on the OCS shelf (shallow water) has been rapidly declining, deepwater gas production has been increasing, but not quickly enough to make up the difference. Increasing onshore shale gas development, declining offshore gas production, and the increasing efficiency and capacity of existing gas processing facilities are trends that have combined to lower the need for new gas processing facilities along the Gulf Coast in the past 5 years. Combined with this, existing facilities that were already operating at about 50 percent of capacity prior to the 2005 hurricane season are operating at even lower capacity utilization levels now. Spare capacity at existing facilities should be sufficient to satisfy new gas production for many years, although there remains a slim chance that a new gas processing facility may be needed by the end of the 40-year life of a CPA proposed action (Dismukes, official communication, 2011c).

One major development, possibly setting a new trend in processing, is the installation and operation of the Independence Hub. The semisubmersible production facility, anchored in 7,920 ft (2,414 m) of water in Mississippi Canyon Block 920, processes production from 10 fields. All of these fields are developed with subsea infrastructure and are connected to the Hub through 1,100 mi (1,770 km) of umbilical and 210 mi (338 km) of flow lines. Independence Hub was designed for up to 21 exploratory well completions and has the capacity to process 1 Bcf/day of gas, 5,000 bbl/day of condensate, and 3,000 bbl/day of water (USDOI, BOEMRE, 2011e). It has been reported that at full processing capacity, Independence Hub may ultimately represent 10 percent of all natural gas production in the Gulf of Mexico and 1.5 percent of overall U.S. gas supply.

Gas processors' profits are dependent on both the price and supply of natural gas. As production in the GOM declines, competition between gas processors increases, as does the struggle for new sources of supply. This leaves some midstream companies looking to other regions of the country for growth and new investment opportunities. Onshore discoveries in recent years, such as the Haynesville Shale in north Louisiana, are fast providing new hope for the gas processing industry to adjust to reduced production in the Gulf.

Liquefied Natural Gas Facilities

Liquefied natural gas (LNG) is natural gas converted to liquid form by cooling it to a temperature of -256°F (-124°C), the point at which gas becomes liquid. This simple process allows natural gas to be transported from an area of abundance to an area where it is needed. Once the LNG arrives at its destination, it is either stored as a liquid or converted back to natural gas and delivered to end-users. Liquefying gas is not a new process or technology; it is simply a process by which the physical properties of natural gas, primarily methane, are altered in order to transport the commodity from markets where it is abundant to those more limited in supply USDOI, MMS, 2008d).

The natural gas price controls and production shortages of the late 1960's led many U.S. energy planners to look at alternative sources of natural gas to meet domestic energy needs. The crisis of the early 1970's, continuing on for much of the decade, provided the impetus for the first generation of LNG regasification facilities in the United States.

Despite the initial growth of LNG in the late 1970's, policies, markets and the underlying economics of natural gas production changed relatively quickly and left these newly developed facilities economically stranded for almost 20 years. It has not been until the most recent decade that the dynamics of natural gas supply and demand have led to increased interest and investment in LNG. In 2002, FERC issued what became known as the "Hackberry decision" which granted preliminary approval, the first in over 20 years, for the construction of Dynegy's Hackberry LNG facility, located in Hackberry, Louisiana.

The LNG "value chain" (**Figure 4-25**) shows the various stages that natural gas is converted to LNG and delivered to end-users. Exploration and production is the first stage of the process. Here, natural gas reserves are developed, wells are drilled, and production is initiated in order to extract the hydrocarbon and transport it locally to a liquefaction facility for super-cooling. Insulated tankers serve as intermediate storage facilities before the gas is transported internationally.

Two types of regasification facilities, offshore and onshore facilities, are currently in operation or development along the GOM. Onshore regasification facilities have existed for over 40 years. The only real difference between the onshore facilities of today and those of the past are the capacity levels of the facilities. The current facilities are located at or near major ports, where LNG tankers arrive and unload their cargoes. Because of their port locations, they are referred to as "marine" facilities. There are four "original" LNG import facilities located along the Atlantic and Gulf Coasts: Everett, Maine; Cove Point, Maryland; Elba Island, Georgia; and Lake Charles, Louisiana. Due to post-9/11 security concerns, there has been greater interest in locating these facilities offshore, where large LNG tankers can offload their cargoes. The gas will be injected into pipelines and moved onshore, eventually reaching the downstream markets. Offshore facilities, however, are different than their onshore counterparts. They are much newer and have virtually no comparable technological applications on the GOM.

The GOM region is perhaps one of the most unique in the world for its breadth and depth of energy assets, most all of which are supportive of LNG imports. The GOM has some of the largest refinery, petrochemical, and paper-pulp facilities in the world, all of which either consume significant quantities of natural gas for production purposes or transform this raw material into high quality fuels or products. The region also has the largest amount of natural gas processing, storage, and most importantly, transportation assets of anywhere in the U.S. It is these transportation assets (pipelines) that are critical in moving LNG from its source of production to its source of consumption, much like these assets have done for domestic production over the past 50 years.

The wide variety of pipeline systems and delivery markets makes the GOM attractive for LNG developers. In Texas, numerous large interstate pipelines parallel the Gulf Coast shoreline en-route to Louisiana and downstream markets. This allows LNG projects to tie into multiple interstate pipeline systems, with much shorter pipeline construction needs. The capital cost savings could help to mitigate the potential for Gulf Coast prices to trade at discounts to Louisiana. An LNG regasification facility can take advantage of this diverse pipeline system to move natural gas much like producers do today. **Figure 4-25** depicts the GOM gas supply schematic.

Permitting LNG facilities is a lengthy, expensive process that can take years before approvals are given. In addition, the permitting process differs depending upon whether the proposed LNG regasification facility is developed onshore or offshore. Both onshore and offshore projects will engage both Federal and State agencies. The Federal Energy Regulatory Commission is the leading agency for the regulatory review of proposed onshore facilities and the U.S. Coast Guard is the supervising agency for proposed offshore facilities. Both Federal agencies work closely together with the U.S. Dept. of Transportation and other Federal and State agencies to review LNG permit applications.

The application and approval process for offshore LNG facilities are handled through the U.S. Dept. of Transportation, Maritime Administration's Office of Deepwater Ports and Offshore Activities. In total, there have been 18 Deepwater Port License Applications filled for approval. Sixteen of those were filed for licenses to import LNG and two were for importing oil. The application for Main Pass Energy Hub off the Louisiana coast was approved, but the license will not be issued until the applicant is able to meet the financial responsibility requirements of the Deepwater Port Act. Of the 18 applications, 8 have been approved; 7 licenses have been issued to import both LNG and oil and 1 license is pending for a LNG port proposed for construction and operation in the Gulf of Mexico. Of the seven licenses issued, two have been surrendered. One application has been denied, eight applications have been withdrawn, and one application is currently under review (USDOT, MARAD, 2011b).

Gulf Gateway Energy Bridge was the first operational LNG port in the U.S. It commenced operations in 2005 but it has now been retired from service (Excelerate Energy, 2011). The Energy Bridge was the world's first deepwater LNG port and was located 116 mi (187 km) off the south coast of Louisiana in 298 ft (91 m) of water. The owner, Excelerate Energy, stated that the two pipelines through which Gulf Gateway delivered product were damaged during Hurricane Ike in September 2008. Despite the fact that the facility itself was unaffected by the hurricane, neither of the pipelines have been able to return to pre-hurricane service levels. This fact, along with an increased LNG importation capacity in the Gulf Coast, has reduced the need for the deepwater LNG port. Pending permit approval, the facility will be completely decommissioned as soon as practicable (Excelerate Energy, 2011). Port Dolphin, located 28 mi (45 km) off the coast of Tampa Bay, Florida, was approved in October 2009, and the license was issued in April 2010 (USDOT, MARAD, 2011b). In Pascagoula, Mississippi, Gulf LNG Energy's 5 million tons per year terminal started operations in October 2011. It is located on 40 ac (16 ha) on Bayou Casotte and was designed as a more environmentally friendly closed loop facility (Havens, 2009).

Refineries

Petroleum is a mixture of liquid hydrocarbons extracted from geological formations deep under the earth's surface. The exact composition of these hydrocarbons varies with some being extracted in gaseous form, while others are primarily liquid. Hydrocarbons found in the gaseous state are typically called "natural gas," whereas that in liquid form is "petroleum." Crude oil is a mixture of hydrocarbon compounds with other impurities that include oxygen, nitrogen, sulfur, salt, and water. Crude oil varies in color and composition, from a pale yellow, low viscosity liquid to a heavy black "treacle" consistency. Because it is of little use in its raw state, further processing of crude oil is necessary to unlock the full potential of this resource.

Petroleum refineries have emerged over the past 100 years as a variety of different manufacturing units designed to produce physical and chemical changes to turn crude oil into petroleum products. In the early days of petroleum refineries, the process was quite simple and consisted of heating crude oil at various temperatures to extract what at that time was its most important refined product, kerosene. Today, the process includes various types of heating, distilling, and catalytic conversions. A modern refinery will break down crude into a large number of components. Refineries vary in size, sophistication, and cost depending on their location, the types of crude they refine, and the products they manufacture. Because crude oil is not homogeneous (varying in color, viscosity, sulfur content, and mineral content), oil produced from different fields or geographic areas have different quality characteristics that give rise to different economic values.

Crude oil is refined into enumerable products and combinations of products, some of the more important being motor gasoline, diesel fuel, jet fuel, and heating fuel. Some of the refined byproducts from crude oil also serve as important feedstocks for the development of synthetic fabric for cloths, detergents, dry-cleaning solvents, as well as chemical bases for cosmetics and pharmaceutical products and various plastic products from toys to building materials.

Gravity and sulfur content are two very important qualitative distinctions in the refining process. Heavier crudes require more sophisticated processes to produce lighter, more valuable products; therefore, they are expensive to manufacture. These crudes, however, can also be less expensive from an input price perspective. Because of corrosive qualities, crude oil with higher sulfur content makes it more expensive to handle and process. In general, light crudes are more valuable, i.e., they yield more of the lighter, higher-priced products than heavy crudes. The product slate at a given refinery is determined by a combination of demand, inputs, and process units available, and the fact that some products are the result (co-products) of producing other products.

As of January 1, 2011, there were 148 refineries in the U.S, 137 of which were operable. These refineries range in size from small facilities able to process as little as 2,000 bbl of crude oil per day to those able to process over 550,000 bbl/day. Over one-third (37.23%) of operable U.S. petroleum refineries are located in the Gulf States of Alabama, Louisiana, Mississippi, and Texas. About 30 percent of operable refineries are located in Louisiana and Texas alone. Louisiana has 18 operable refineries with a total capacity of over 3 MMbbl per day, representing 18 percent of U.S. operable refining (USDOE, Energy Information Administration, 2011f). **Figures 4-22 and 4-46** illustrate the geographic distribution of refineries across the CPA analysis area. There are only three refineries in Alabama and one in Mississippi. There are no refineries in Florida. **Table 3-13** gives the numerical distribution of refinery facilities by state.

Given the concentration of refineries in the region, the Gulf Coast is not surprisingly the Nation's leading supplier in refined products. Refined products are shipped from the Gulf Coast to both the East Coast and the Midwest. Gulf Coast refineries supply the East Coast with more than half of its need for light products such as gasoline, heating oil, diesel, and jet fuel. Over 20 percent of the Midwest's light product consumption also comes from the Gulf Coast despite the fact that there are a considerable number of refineries located within the region in Ohio, Illinois, and Indiana (USDOE, Energy Information Administration, 2011f).

The largest importer of crude oil and finished products is the Gulf Coast. These imports, however, are not primarily for finished refined products, but they are more concentrated on refinery feedstock and blendstock, which are needed to supplement the considerable regional refining and petrochemical capacity. In addition, a significant portion of the Midwest's non-Canadian crude imports move through the Gulf Coast's ports and pipelines. This makes the Gulf Coast the most important crude importing region in the U.S., accounting for over 50 percent of the U.S. total crude and petroleum product imports (USDOE, Energy Information Administration, 2011g).

Refineries are owned by either large integrated petroleum companies (such as ExxonMobil, Chevron, or ConocoPhillips) or independent refiners such as Valero, Motiva, or Calumet. Many of the large integrated companies are engaged on a national or international basis in many segments of the petroleum products business, including refining, transportation, and marketing.

Although refineries are not regulated economically, they are affected by environmental regulations and legislation. The refining industry is also impacted by regulations placed on the way petroleum is produced, imported, stored, transported, and consumed in the U.S.

In the spring of 1989, USEPA implemented a two-phased program limiting summertime motor gasoline volatility (the rate at which gasoline evaporates into the air) in some U.S. lower 48 urban areas in order to combat emissions of volatile organic compounds (VOC's) and other ozone precursors.

The 1990 Amendments to the Clean Air Act of 1970 (CAAA) imposed strict new controls to reduce mobile sources of air pollution. The CAAA contained six provisions to be implemented by USEPA in stages between November 1, 1992, and January 1, 2000. Four major programs to reduce harmful emissions from highway fuel were slated to go into effect between November 1, 1992, and January 1, 1996. These programs included the Oxygenated Fuels Program (1992), the Highway Diesel Fuel Program (1993), the Reformulated Gasoline Program (1995), and the Leaded Gasoline Removal (1995).

The CAAA forced many refineries to make considerable investments in oxygenates production facilities. Other investments that arose in the aftermath of the CAAA included the construction of desulfurization units, in particular catalytic hydrocracking and hydrotreating units. These investments began to increase after 1980 as heavier, higher-sulfur crude oils became available to U.S. refiners but increased rapidly in reaction to the new clean gasoline standards, particularly diesel standards resulting from the CAAA. New hydrostatic treatment facilities also significantly increased the hydrogen production and use requirements for most refineries.

According to the Energy Information Administration, there are 37 refineries operating in Gulf with a total capacity of 7.2 MMbbl/day (USDOI, Energy Information Administration, 2011g). The U.S. refining industry's ability to meet short-term increases in demand can also be measured by refinery utilization rates which are simply the ratio of gross inputs to crude oil distillation units divided by operable capacity. Utilization rates can fluctuate over time as demand, as well as the addition of new capacity, changes. The decade of the 1990s was one of the most challenging for most refinery owners and operators, and it is characterized by very low product margins and profitability given the past capacity over-development. Excess capacity, coupled with considerable new regulatory requirements (and operating investments) needed to comply with the CAAA further increased the cost of a very high-cost sector of the industry.

Since 2000, refining capacity has increased by five percent with high utilization (between 90% and 93%), despite the fact that no new greenfield refinery has been constructed since the mid-1970's (the Marathon facility at Garyville, Louisiana, in 1976). Furthermore, cyclical differences between refined product output and demand are increasingly being met with imports from excess capacity in other parts of the world rather than on developing new domestic capacity. Most refineries are part of major, vertically integrated oil companies that are engaged in both upstream and downstream aspects of the petroleum industry. A wave of mergers that began in the 1990's, however, has whittled down the number of these vertically integrated giant oil companies and has resulted in considerable market consolidation. For instance, the top 10 U.S. refiners in 1994 accounted for 57 percent of the market, while today the top 10 U.S. refiners, most of them major integrated oil companies, account for 75 percent of the total domestic refinery operating capacity (USDOE, Energy Information Administration, 2011h).

Petrochemical Plants

The chemical industry converts raw materials (oil, natural gas, air, water, metals, and minerals) into more than 70,000 different products. After natural gas is processed and crude oil is refined, the non-fuel components are typically used as a feedstock, forming the production basis for what is known as "petrochemicals." Petroleum is composed mostly of hydrogen and carbon compounds (called hydrocarbons). It also contains nitrogen and sulfur, and all four of these ingredients are valuable in the manufacturing of chemicals.

The petrochemical industry is somewhat amorphous and can be difficult to define, particularly around the boundaries. The upstream side of the business is typically defined by the production and primary use of crude oil and natural gas by-products. As one moves downstream, the introduction of industries and facilities that combine petrochemical manufacturing and other organic chemistry-based industries such as plastics, synthetic fibers, agricultural chemicals, paints and resins, and pharmaceuticals are usually included. Quite often, companies owning and operating facilities in this industry are petroleum companies who have broadened their interests into chemicals, chemical companies who buy petroleum raw materials, and joint ventures between chemical and petroleum companies. For instance, Shell, ExxonMobil, and Occidental Petroleum have chemical/petrochemical operations. In fact, co-location of chemical and refining operations creates efficiencies and synergies that keep many of these facilities operational in an otherwise mature high-cost environment that defines North American and European operations.

The transformation of raw hydrocarbons into intermediate and final chemical products requires chemical, physical, and biological separation and synthesis processes. These processes expend large amounts of energy for heating (i.e., heat and steam), cooling, and electrical power. Separations play a critical role and account for 40-70 percent of both capital and operating costs. Distillation, which is comprised primarily of subjecting a feedstock to high temperatures, like a boiling process, is the most widely used chemical separation process and accounts for as much as 40 percent of the chemical industry's energy use. Chemical synthesis and process heat also play major roles in nearly all chemical operations along the GOM.

Petrochemical plants are usually located in areas with close proximity to raw materials (petroleum-based inputs) and multiple transportation routes, including rail, road, and water. In many instances, such as development along the GOM, chemical plants arise because of their close proximity to other plants, which can often be their best customers. As noted earlier, it is common for large integrated oil and gas companies that own refineries to have nearby chemical plant affiliates to take advantage of particular waste streams.

Laid out like industrial parks, most petrochemical complexes include plants that manufacture any combination of primary, intermediate, and end-use chemical products. Changes in market conditions and technologies are often reflected over time as input and product slates are changed. In general, petrochemical plants attempt to run in an "optimized" fashion by attaining the cheapest manufacturing costs and producing the largest level of output while taking advantage of any and all co-locational synergies. Product slates and system designs are carefully coordinated to optimize the use and output of chemical by-products and to use steam, heat, and power as efficiently as possible.

The petrochemical industry is very energy intensive and uses a variety of energy sources, nearly 50 percent of which are used as feedstock. According to the Energy Information Administration's Manufacturing Energy Consumption Survey in 2006, and as revised in November 2009, the chemical industry uses 5,149 trillion Btu per year (fuel and non-fuel), which is over 24 percent of the total energy used by the nation's manufacturing sector. In addition, the chemical industry is the single largest consumer of natural gas (over 29% of the domestic total) and uses nearly all the liquefied petroleum gas and natural gas liquids consumed in U.S. manufacturing (USDOE, Energy Information Administration, 2011i).

Texas, New Jersey, Louisiana, North Carolina, and Illinois are the top domestic chemical producing states. However, most of the basic chemical production is concentrated along the Gulf Coast, where petroleum and natural gas feedstock are available from refineries. Of the top 10 ethylene production complexes in the world, 5 are located in Texas and 1 is located in Louisiana. These six production complexes account for 30 percent of the U.S. ethylene production capacity.

Along the GOM, the petrochemical industry is heavily concentrated in coastal south Louisiana and in various counties along the Alabama, Mississippi, and Florida coasts. The majority of petrochemical plants in the CPA are located in Louisiana (66). **Table 3-13** provides the numerical distribution for each state in the analysis area. **Figures 4-22 and 4-46** illustrate the geographical distribution of petrochemical facilities across the CPA analysis area. In many ways, these petrochemical facilities can be thought of as another form of "hydrocarbon processor." They use natural gas, liquefied petroleum gas, and natural gas liquids to create products much like a refinery takes crude oil and converts it into a variety of products such as gasoline, distillates, kerosene, and other products.

Companies that have the ability to utilize a large amount and broad range of feedstocks, including heavy liquids, historically have a competitive advantage in the petrochemical industry. Competition is based upon price, product quality, product delivery, reliability of supply, and product performance. Like refining, recent industry consolidation has brought North American petrochemical production capacity under the control of fewer companies. Competition for market share is intense and fought for by both chemical corporations and chemical divisions of major international oil companies. Competition between these entities has historically been quite strong, and it is expected to continue in the future.

Petrochemical plants are affected by nearly all Federal environmental statutes including the Toxic Substances Control Act, the Clean Air Act, the Clean Water Act, the Comprehensive Environmental Response Compensation and Liability Act of 1980, the Emergency Planning and Community Right-to-Know Act, and the U.S. Dept. of Homeland Security's final rule that imposes comprehensive Federal security regulations for high-risk chemical facilities called Chemical Facility Anti-Terrorism Standards.

The industry is also subject to numerous laws and health, safety, and environmental regulations from State and local governments.

Over the years, the petrochemical industry has faced many challenges. Extensive environmental, health, and safety laws have been passed throughout the years, and now issues about global warming are inspiring even more attention on the chemical industry. Feedstock and energy costs have been highly variable and supply availabilities are becoming increasingly as important as price. Over the past decade, there has been increased competition for petrochemical sales worldwide. Also, globalization and information technology have significantly affected the organization of petrochemical businesses worldwide.

Deepwater Horizon Event

In response to the DWH event, U.S. Dept. of the Interior Secretary Ken Salazar imposed a suspension on all offshore drilling. The initial suspension was modified on May 27, 2010, to allow drilling only in shallow waters <500 ft (152 m) deep (USDOI, Office of Public Affairs, 2010). However, only a limited amount of drilling has actually resumed because of new information requirements as clarified in NTL 2010-N06, the time it takes for operators to comply, and the rate at which BOEM and BSEE are able to process permit applications (Weinstein, 2010). On October 12, 2010, the last remaining deepwater drilling suspension was lifted, but, as in the case of shallow-water drilling, deepwater drilling would not re-commence immediately and is dependent upon operators fulfilling stringent requirements and BOEM and BSEE approvals. In the months following the DWH event and the declared suspension, companies removed a large portion of their equipment from Port Fourchon, and there was a substantial decrease in helicopter flights and servicing of rigs. Many companies trimmed their budgets by cutting hours and salaries. Support services companies, such as chemical suppliers, and welders, were also negatively affected (Lohr, 2010). The effects of this decreased demand rippled through the various infrastructure categories (e.g., fabrication yard, shipyards, port facilities, pipecoating facilities, gas processing facilities, waste management facilities, etc.) and also affected the oil and gas support sector businesses (e.g., drilling contractors, offshore support vessels, helicopter hubs, mud/drilling fluid/lubricant suppliers, etc.) because the decrease in offshore drilling activity translates into a decrease in demand for services. For example, the impacts of the suspension and permitting delays are being experienced at Port Fourchon, where rental rates were cut by 30 percent through June 30, 2011 as an incentive for businesses to stay. This amounted to a $3 million revenue loss for The Greater Lafourche Port Commission. As of June 2011, businesses operating out of Port Fourchon were collectively operating at about 30 percent capacity compared with pre-DWH levels. Activity levels are very slowly improving at Port Fourchon, and according to the Executive Port Director, the main concern now is the current pace of exploration plan approvals. While production has been ongoing since the DWH event, the majority of the Port's business is in drilling and exploration activities (Chaisson, official communication, 2011). Because petroleum activities on the OCS and in State waters and coastal areas are driven by market forces, the DWH event and related events are not expected to have long-term consequences on petroleum activities. Hence, these events are not expected to affect land use and infrastructure in the cumulative case.

The BOEM will continue to monitor these infrastructure effects as they evolve over time. Although this information on infrastructure effects is evolving and may be relevant to reasonably foreseeable significant impacts to the Gulf economy, this information would not be essential to a reasoned choice among the alternatives because regardless of whether the decisionmaker chooses to hold a lease sale under the action alternatives or chooses the No Action Alternative, there remain many preexisting OCS leases in the WPA and CPA that would continue to support the economy. A CPA proposed action would not be expected to, on its own, result in significant impacts. The incomplete or unavailable information, even if available, would not be expected to change these conclusions.

Land use experienced a more immediate but short-term impact, with temporary waste staging areas and decontamination areas that were set up to handle the spill-related waste. Concerns about waste management practices were expressed by government and the public (Barringer, 2010). The USEPA, in consultation with USCG, issued solid-waste management directives to address the issue of contaminated materials, and solid or liquid wastes that were recovered as a result to cleanup operations (USEPA, 2010d and 2010e). Twenty-five waste staging areas were set up across Louisiana, Mississippi, Alabama, and Florida. Six decontamination areas were stationed in Mississippi, Alabama, and Florida. The USEPA visited each staging and decontamination area once per week and each landfill two times per month; their findings were documented on USEPA's website. There were some issues, mainly concerns over leaking receptacles and waste management practices during the immediate aftermath of the spill, but nothing that would appear to cause a long-term impact (USEPA, 2010f).

4.2.1.23.1.2. Impacts of Routine Events

Routine events in the GOM region can produce impacts to land use and coastal infrastructure, some adverse and some beneficial. **Chapter 3.1.2** discusses the coastal impact producing factors and scenario for onshore infrastructure.

Proposed Action Analysis

Impact-producing factors associated with a CPA proposed action that could affect land use and coastal infrastructure include (1) gas processing facilities, (2) pipeline landfalls, (3) service bases, (4) navigation channels, and (5) waste disposal facilities.

Chapter 3.1.2.1 of discusses projected new coastal infrastructure that may result from a CPA proposed action, including the potential need for the construction of new facilities and/or the expansion of existing facilities. All onshore infrastructure requires permits for construction and operation. The BOEM is not the permitting agency for these activities. The permitting agencies for any onshore infrastructure would be the State in which the activity would occur, and/or COE, and/or USEPA. According to the scenario analysis in **Chapter 3.1.2.1.4.2**, the construction of 0-1 new gas processing facilities would be expected to occur near the end of the 40-year life of a CPA proposed action. Most of the projected new pipeline would be offshore and would tie into the existing offshore pipeline infrastructure. According to the scenario analysis, 0-1 new pipeline landfalls would be expected to occur toward the end of the 40-year lifespan of a CPA proposed action. According to these BOEM projections, no other new coastal infrastructure would be expected to result from a CPA proposed action. Given the uncertain environment of the post-DWH event, the application of the scenario revised for a CPA proposed action is very conservative since the likelihood is diminished that any new gas processing facility or pipeline landfall would result from a CPA proposed action. That is, the effect of the drilling suspensions, changes in Federal requirements for drilling safety, and the current pace of permit approvals has depressed existing demand for gas processing facilities and pipeline landfalls; hence, the likelihood of new gas processing facilities or pipeline landfalls has moved closer to zero and farther from one (Dismukes, official communication, 2011a). However, BOEM continues to monitor all resources for changes that are applicable to land use and infrastructure. Maintenance dredging of existing navigation channels is still expected, but no new navigation channels are expected to be dredged as a result of a CPA proposed action. The volume of OCS-generated waste is closely correlated with the level of offshore drilling and production activity. Demand for waste disposal facilities is influenced by the volume of waste generated. At this time, it is unclear how long the current slowdown in activity will continue or how it might affect later years. Until OCS drilling activity recovers, potential for a new waste facility as a result of a CPA proposed action is highly unlikely.

Chapters 4.2.1.23.1.1 and 3.1.2.1.4.2 discuss gas processing plants and the potential for new facilities and/or expansion at existing facilities. Over the past 5 years, there has been a substantial decrease in offshore natural gas production, partially as a result of increasing emphasis on onshore shale gas development, which is less expensive to produce and provides larger per well production opportunities and reserve growth. Also, there has been a trend toward more efficient gas processing facilities with greater processing capacities. In Alabama, Mississippi, and the eastern portion of south Louisiana, plant capacity increased significantly as plant expansions occurred and new larger plants were built in response to offshore production (USDOE, Energy Information Administration, 2006). While natural gas production on the OCS shelf (shallow water) has been rapidly declining, deepwater gas production has been increasing, but not quickly enough to make up the difference. Increasing onshore shale gas development, declining offshore gas production, and the increasing efficiency and capacity of existing gas processing facilities are trends that have combined to lower the need for new gas processing facilities along the Gulf Coast in the past several years. Combined with this, existing facilities that were already operating at about 50 percent of capacity prior to the 2005 hurricane season are operating at even lower capacity utilization levels now. Spare capacity at existing facilities should be sufficient to satisfy new gas production for many years, although there remains a slim chance that a new gas processing facility may be needed by the end of the 40-year life of a CPA proposed action (Dismukes, official communication, 2011d).

The BOEM analyzes the potential for new pipeline landfalls to determine the potential impacts to wetlands and other coastal habitats. In **Chapter 3.1.2.1.6**, BOEM assumes that the majority of new Federal OCS pipelines would connect to the existing infrastructure in Federal and State waters and that very few would result in new pipeline landfalls. Therefore, BOEM projects up to one pipeline landfall per CPA proposed action. Prior to this EIS, the Bureau of Ocean Energy Management tested this assumption by analyzing past lease sale outcomes (USDOI, MMS, 2007a). This analysis shows that it is generally unlikely that even one landfall would result from a CPA proposed action. A mature pipeline network already exists in the Gulf of Mexico and companies have very strong financial incentives to reduce their costs by designing and utilizing pipeline systems to their fullest extent possible. Companies consider "economies of scale" in pipeline transportation, maximizing the amount of product moved through a constructed pipeline to decrease the long-run, average cost of production. Mitigation costs for any new wetland and environmental impacts, as well as various landowner issues at the landfall point are additional considerations. These are strong incentives to move new production into existing systems and to avoid creating new landfalls (USDOI, MMS, 2007a). This analysis confirms BOEM's assumption that the majority of new pipelines constructed would connect to the existing infrastructure in Federal and State waters and that very few would result in new pipeline landfalls. However, there may be instances where new pipelines would need to be constructed. Location would be a determining factor; if there are no existing pipelines reasonably close and it is more cost effective to construct a pipeline to shore, then there may be a new OCS pipeline landfall. However, the very strong financial incentives to link into the existing, mature pipeline network make this highly unlikely (Dismukes, official communication, 2011a). **Chapters 4.2.1.3.2 and 4.2.1.4.2** provide a detailed discussion of coastal barrier beaches and wetlands, respectively, and potential pipeline landfall impacts to those resources.

Chapters 4.2.1.23.1.1 and 3.1.2.1.1 present a description of OCS-related service bases. A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel that are needed at offshore work sites. A CPA proposed action is not projected to change existing OCS-related service bases or require construction of new service bases. Instead, it would contribute to the use of existing service bases. **Figure 4-24** shows the 50 service bases the industry currently uses to service the OCS. These facilities are identified as the primary service bases from plans received by BOEM. The ports of Fourchon, Cameron, Venice, and Morgan City, Louisiana, are the primary service bases for Gulf of Mexico mobile rigs. Major platform service bases in the CPA are Cameron, Fourchon, Intracoastal City, Morgan City, and Venice, Louisiana; Pascagoula, Mississippi; and Theodore, Alabama.

Service bases are utilized for various types of OCS offshore support. The most prevalent categories of OCS offshore support include supply vessels, crewboats, and helicopters. Supply vessels transport pipe and bulk supplies, and the supply vessel base serves as the loading point and provides temporary storage. Crewboats transport personnel and small supplies. Collectively, supply vessels and crewboats are known as OSV's. There are approximately 1,200 OSV's operating in the GOM. Important drivers for the OSV market include the level of offshore exploration and drilling activities, current oil and gas prices, expectations for future oil and gas prices, and customer assessments of offshore prospects (Dismukes, 2011b). High demand for OSV's translates into a positive impact on OCS-related employment (see **Chapter 4.2.1.23.3.2**, "Economic Factors" below). Helicopters transport small supplies and workers and also may patrol pipelines to spot signs of damage or leakage. Helicopters service drilling rigs, production platforms, and pipeline terminals, as well as specialized vessels, such as jack-up barges. The OCS activity levels and offshore oil and gas industry transportation needs substantially influence the demand for and profitability of helicopter services (Dismukes, 2010). Exploration and development plans filed with BOEM identify the expected number and frequency of vessel and helicopter trips, and the primary and secondary service bases for each project. In the event of changes in weather or operation conditions, a small amount of vessel and helicopter traffic may be dispatched from other bases. However, these deviations would occur on a temporary basis, and vessel traffic and helicopter transport should return to the primary and secondary bases as timely as possible.

Chapter 3.1.2.1.8 discusses navigation channels along the Gulf Coast. Much of the traffic navigating these channels is unrelated to OCS activity, and the current system of navigation channels in the northern GOM is projected to be adequate for accommodating traffic generated by a CPA proposed action. The Gulf-to-port channels and the Gulf Intracoastal Waterway that support prospective OCS ports are generally deep and wide enough to handle OCS-related traffic and are maintained by regular dredging

(**Figure 3-7**). The COE is the responsible Federal agency for the regulation and oversight of navigable waterways. The maintained depths for these waterways are shown in **Table 3-14**. All lease sales contribute to the demand for OSV support; hence, it also contributes to the vessel traffic that moves in and out of support facilities. Therefore, a CPA proposed action is likely to contribute to the continued need for maintenance dredging of existing navigation channels. However, no new navigation channels are expected to be dredged as a result of a CPA proposed action because the existing system of navigation channels is projected to be adequate to allow proper accommodation for vessel traffic that would occur as a result of a CPA proposed action. Maintenance dredging is essential for proper water depths in channels to allow all shipping to move safely through the waterways to ports, services bases, and terminal facilities. Several million cubic yards of sand, gravel, and silt are dredged from waterways and harbors every year. This is a controversial process because it necessarily occurs in or near environmentally sensitive areas such as valuable wetlands, estuaries, and fisheries (Dismukes, 2010). **Chapter 4.2.1.4.2** provides a discussion of wetlands and the impacts of navigation channel dredging.

Chapters 4.2.1.23.1.1 and 3.1.2.2 discuss OCS waste disposal. The scenario analysis concluded that no new solid-waste facilities would be built as a result of a single lease sale. Focused scenario analysis research into onshore waste disposal further supports the conclusion that existing solid-waste disposal infrastructure is adequate to support both existing and projected offshore oil and gas drilling and production needs (Dismukes et al., 2007b). The industry trend is toward innovative methods to handle wastes to reduce the potential for environmental impacts; e.g., hydrocarbon recovery/recycling programs, slurry fracture injection, treating wastes for reuse as road base or levee fill, and segregating waste streams to reduce treatment time and improve oil recovery. The volume of OCS waste generated is closely correlated with the level of offshore drilling and production activity (Dismukes, 2010). Before the DWH event, BOEM analyses indicated that there was an abundance of solid-waste capacity in the GOM region and thus highly unlikely that any new waste facilities would be constructed. If any increase in the need for capacity develops, it would probably be met by expansion of existing facilities. However, now it is unclear whether this would remain true, and more research is needed (Dismukes, official communication, 2011a). In recent months, due to the drilling suspensions and current pace of permit approvals, there has been some reduction in offshore drilling activity. Given this situation, the demand for waste disposal facilities may not be likely to increase. However, at this time BOEM cannot predict how long this current pace will continue or how long it will take for activity levels to recover. The BOEM continues to monitor waste-disposal demands and activity in the post-DWH event environment. **Chapter 4.2.1.23.4.2** provides a discussion of environmental justice issues related to waste disposal facilities.

Summary and Conclusion

The impacts of routine events associated with a CPA proposed action are uncertain due to the post-DWH event environment, the effects of the drilling suspension, the changes in Federal requirements for drilling safety, and the current pace of permit approvals. The BOEM projects 0-1 new gas processing facilities and 0-1 new pipeline landfalls for a CPA proposed action. However, based on the most current information available, there is only a very slim chance that either would result from a CPA proposed action, and if a new gas processing facility or pipeline landfall were to result, it would likely occur toward the end of the 40-year analysis period. The likelihood of a new gas processing facility or pipeline landfall is much closer to zero than to one (Dismukes, official communication, 2011a). The BOEM anticipates that there would be maintenance dredging of navigation channels and an increase in activity at services bases as a result of a CPA proposed action. If drilling activity recovers post-DWH event and increases, there could be new increased demand for a waste disposal services as a result of a CPA proposed action. Because of the current near zero estimates for a pipeline landfall and gas processing facility construction, the routine activities associated with a CPA proposed action would have little effect on land use.

As a result of the DWH event, it is too early to determine substantial, long-term changes in routine event impacts to land use and infrastructure. The BOEM anticipates these changes would become apparent over time. Therefore, BOEM recognizes the need to continue monitoring all resources for changes that are applicable for land use and infrastructure. From the information described above, in regard to land use and infrastructure, it does not appear that there would be adverse impacts from routine events associated with a CPA proposed action.

4.2.1.23.1.3. Impacts of Accidental Events

Proposed Action Analysis

Accidental events (impact-producing factors) associated with a CPA proposed action that could affect land use and coastal infrastructure include (1) oil spills, (2) vessel collisions, and (3) chemical/drilling-fluid spills. The DWH event was an accidental event of historic and catastrophic proportion, the largest blowout in U.S. history, and the first to occur on the OCS in over 30 years. Such events should be distinguished from accidental events that are smaller in scale and that occur more frequently. **Chapter 3.2.1** provides a detailed discussion of oil spills that have occurred and their frequency. A detailed analysis of a low-probability catastrophic event such as DWH event is provided in **Appendix B**.

Oil spills may be associated with exploration, production, or transportation activities that result from a CPA proposed action. Detailed risk analysis of offshore oil spills ≥1,000 bbl, <1,000bbl, and coastal spills associated with a CPA proposed action is provided in **Chapters 3.2.1.5, 3.2.1.6, and 3.2.1.7**. Because oil spilled in the offshore areas normally volatilizes and is dispersed by currents, it has a low probability of contacting coastal areas. Oil spills in coastal and inland waters, such as spills resulting from the operations of offshore supply vessels, pipelines, barges, tanker ships, and ports are more likely to affect BOEM-recognized coastal infrastructure categories. For example, if waterways are closed to traffic, this may result in impacts to upstream and downstream business interests as it impedes the flow of commerce. The mean number and sizes of spills estimated to occur in OCS offshore waters from an accident related to rig/platform and pipeline activities supporting a CPA proposed action over a 40-year period are presented in **Table 3-12**.

Vessel collisions may be associated with exploration, production, or transportation activities that result from a CPA proposed action. **Chapter 3.2.4** provides a detailed discussion of vessel collisions. The BOEM data show that, from 1996 through 2009, there were 226 OCS-related collisions. The majority of vessel collisions involve service vessels colliding with platforms or pipeline risers, although sometimes vessels collide with each other. Human error accounted for about half of all reported vessel collisions from 1996 through 2009. These collisions often result in spills of various substances and, while most occur on the OCS far from shore, ones in coastal waters can have consequences to land use and coastal infrastructure. For example, on July 23, 2008, a barge carrying heavy fuel collided with a tanker ship in the Mississippi River at New Orleans, Louisiana. Over several days the barge leaked approximately 419,000 thousands of gallons of fuel. From New Orleans to the south, 85 mi (137 km) of the river were closed to all traffic while cleanup efforts were undertaken, causing a substantial backup of river traffic (USDOC, NOAA, 2008c). On Tuesday July 27, 2010, a dredge vessel ran into a wellhead in the Barataria Waterway. The wellhead leaked a mixture of oil, natural gas, and water into Barataria Bay. A sheen covered more than 6 mi^2 (16 km^2) of water. Over 150 spill-response personnel and 31 boats initially responded to the accident (*Coast Guard News*, 2010). As of August 3, 2010, approximately 35 bbl of oily-water mix were recovered (OffshoreEnergyToday, 2010).

Chemical/drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a CPA proposed action. **Chapter 3.2.5** provides a detailed discussion of chemical and drilling-fluid spills. Each year, between 5 and 15 chemical spills are expected to occur; most of these are ≤50 bbl in size. Large spills are much less frequent. For example, from 1964 to 2005, only two chemical spills of ≥1,000 bbl occurred. Even though additional production chemicals are needed in deepwater operations where hydrate formation is a possibility, spill volumes are expected to remain stable because of advances in subsea processing.

With the exception of a catastrophic accidental event, such as the DWH event, the impact of oil spills, vessel collisions, and chemical spills are not likely to last long enough to adversely affect overall land use or coastal infrastructure in the analysis area.

***Deepwater Horizon* Event**

While it is too early to determine the final outcome and impacts of the DWH event, information is gradually becoming available, particularly on short-term impacts. In the months following the DWH event, there were some short-term, indirect impacts on land use and coastal infrastructure caused by the drilling suspension imposed on July 12, 2010, and lifted on October 12, 2010; by changes in Federal requirements for drilling safety; and by the pace of the permit approval process. Drilling resumed in shallow and deep waters, but it depends on meeting new drilling application requirements as clarified in

NTL 2010-N06. The impacts of the suspension were experienced at Port Fourchon, Louisiana, where rental rates were cut by 30 percent as an incentive for businesses to stay. Companies removed a large portion of their equipment from the port and there was a substantial decrease in helicopter flights and the servicing of rigs. Many companies trimmed their budgets by cutting hours and salaries. Support services companies, such as chemical suppliers, and welders also were affected. As of June 2011, businesses operating out of Port Fourchon were collectively operating at about 30 percent capacity compared with pre-DWH levels (Chaisson, official communication, 2011).

The deepwater exploration activity at Port Fourchon is expected to resume with the approval of deepwater permits. The rate of drilling is dependent upon compliance with more stringent Federal enforcement, the industry's efforts to fulfill new safety requirements that are not yet finalized, and the resulting slow pace for drilling application approvals. Deepwater exploratory drilling is a huge economic driver for jobs, investments, vessels, etc. (Chaisson, official communication, 2011). In the long term, the effects of the suspension and its aftermath are not expected to change the basic market fundamentals that drive demand for support infrastructure. In the short term, the decrease in deepwater exploratory drilling is expected to ripple through the various infrastructure categories (e.g., fabrication yard, shipyards, port facilities, pipecoating facilities, gas processing facilities, waste management facilities, etc.) and would also affect the oil and gas support sector businesses (e.g., drilling contractors, offshore support vessels, helicopter hubs, mud/drilling fluid/lubricant suppliers, etc.). See **Chapter 4.2.1.23.3** for a detailed analysis of economic factors. The BOEM will continue to monitor these infrastructure effects as they evolve over time. Although this information on infrastructure effects is evolving and may be relevant to reasonably foreseeable significant impacts to the Gulf economy, this information would not be essential to a reasoned choice among the alternatives because regardless of whether the decisionmaker chooses to hold a proposed lease sale under the action alternatives or chooses the No Action Alternative, there remain many preexisting OCS leases in the WPA and CPA that would continue to support the economy. A CPA proposed action would not be expected to, on its own, result in significant impacts. The incomplete or unavailable information, even if available, would not be expected to change these conclusions.

Land use experienced more immediate, short-term impacts from the establishment of temporary waste staging areas and decontamination areas set up to handle spill-related waste. Concerns about waste management practices were expressed by government and the public (Barringer, 2010). The USEPA, in consultation with USCG, issued solid-waste management directives to address the issue of contaminated materials, and solid or liquid wastes that were recovered as a result to cleanup operations (USEPA, 2010d and 2010e). Twenty-five waste staging areas were set up across Louisiana, Mississippi, Alabama, and Florida. Six decontamination areas were stationed in Mississippi, Alabama, and Florida. The USEPA visited each staging and decontamination area once per week and each landfill two times per month; their findings are documented on USEPA's website. There were some issues, mainly concerns over leaking receptacles and waste management practices during the immediate aftermath of the spill, but nothing that would appear to cause a long-term impact (USEPA, 2010f). **Chapter 4.2.1.23.4** provides an additional discussion of environmental justice issues related to the DWH event's waste stream. A detailed analysis of a low-probability catastrophic event such as the DWH event may be found in **Appendix B**.

Summary and Conclusion

Accidental events associated with a CPA proposed action would occur at different levels of severity, based in part on the location and size of event. The typical types of accidental events that could affect land use and coastal infrastructure include oil spills, vessel collisions, and chemical/drilling-fluid spills. These may occur anywhere across the spectrum of severity. Typically, accidental events related to OCS activities are generally smaller in scale based on historic experience, and they must be distinguished from low-probability catastrophic events such as the DWH event. Typically, the impact of small-scale oil spills, vessel collisions, and chemical/drilling fluid spills are not likely to last long enough to adversely affect overall land use or coastal infrastructure in the analysis area.

Many of the impacts of the DWH event to land use and infrastructure have been temporary and short-term, such as the ship decontamination sites and the waste staging areas established in the immediate aftermath of the DWH event (USDOT, 2010). The indirect effects on infrastructure use are still rippling through the industry, but this should resolve as issues with the suspensions, permitting, etc. are resolved. With regards to land use and infrastructure, the post-DWH event environment remains somewhat dynamic, and BOEM will continue to monitor these resources over time and to document short- and long-term DWH event impacts. In the future, the long-term impacts of the DWH event will be clearer as time allows the production of peer-reviewed research and targeted studies that determine those impacts. The DWH event was a low-probability catastrophic event. For the reasons set forth in the analysis above, the kinds of accidental events that are likely to result from a CPA proposed action are not likely to significantly affect land use and coastal infrastructure. This is because accidental events offshore would have a small probability of impacting onshore resources. Also, if an accident occurs nearshore, it would be most probably be near a facility; therefore, the impacts would be temporary and localized because of the decrease in response time.

4.2.1.23.1.4. Cumulative Impacts

Background/Introduction

The cumulative analysis considers the effects of impact-producing factors from OCS and State oil and gas activities. The OCS- and State-related factors consist of prior, current, and future OCS and State lease sales. **Chapter 4.2.1.23.1.1** discusses the socioeconomic analysis area, land use, and OCS-related oil and gas infrastructure associated with the analysis area. The vast majority of this infrastructure also supports oil and gas production in State waters as well as in coastal areas onshore.

According to BOEM development scenario analysis, the construction of 0-1 new gas processing facilities would be expected to occur near the end of the 40-year life of a CPA proposed action. Most new pipelines would be offshore and would tie into the existing offshore pipeline infrastructure. According to the scenario analysis, 0-1 new pipeline landfalls would be expected to occur toward the end of the 40-year lifespan of a CPA proposed action. Those projections also called for no new waste disposal facilities due to existing excess capacity along the Gulf Coast. Research based on the analysis of historical data further validated BOEM’s past scenario projections of new gas processing facilities and new pipeline landfalls and found its projections to be conservative; that is, the actual numbers proved to be equal to, or less than, the projected numbers. Current scenario projections also are likely to be conservative (Dismukes, official communication, 2011a).

In the months following the DWH event, much information has been generated regarding the consequences of the oil spill and subsequent drilling suspensions. Because petroleum activities on the OCS and in State waters and coastal areas are driven by market fundamentals, the DWH event and related events are not expected to have long-term consequences on petroleum activities. Hence, these events are not expected to affect land use and infrastructure in the cumulative case. However, because the post-DWH event environment is dynamic and ever-changing, BOEM is currently conducting ongoing monitoring of post-DWH event impacts to land use and coastal infrastructure, and BOEM will conduct targeted and peer-reviewed research should this monitoring identify long-term impacts of concern.

Land use in the analysis area will evolve over time. The majority of change is likely to occur from general, regional economic and demographic growth rather than from activities associated with current OCS and/or State offshore petroleum production or future planned OCS or State lease sales. The BOEM development scenarios consider demand from both current and future OCS and State leases. These scenarios project 0-1 new gas processing facilities to result from a CPA proposed action. However, this number is derived from the estimated demand for future processing capacity. Given current industry practice, it is likely that few (if any) new, Greenfield gas processing facilities would actually be constructed along the CPA. Instead, it is likely that a large share (and possibly all) of any additional natural gas processing capacity that is needed in the industry would be developed at existing facilities through future investments in expansions and/or replacement of depreciated capital equipment. Also, these BOEM scenario projections are conservative; i.e., they likely overestimate the additional capacity that would be required.

Over the past several years, there has been a substantial decrease in offshore natural gas production, partially as a result of increasing emphasis on onshore shale gas development, which is less expensive to produce and provides larger per-well production opportunities and reserve growth. Also, there has been a trend toward more efficient gas processing facilities with greater processing capacities (Dismukes, 2010). In Alabama, Mississippi, and the eastern portion of South Louisiana, plant capacity increased significantly as plant expansions occurred and new larger plants were built in response to offshore production (USDOE, Energy Information Administration, 2006). While natural gas production on the

OCS shelf (shallow water) has been rapidly declining, deepwater gas production has been increasing, but not quickly enough to make up the difference. Increasing onshore shale gas development, declining offshore gas production, and the increasing efficiency and capacity of existing gas processing facilities are trends that have combined to lower the need for new gas processing facilities along the Gulf Coast. Combined with this, existing facilities that were already operating at about 50 percent of capacity prior to the 2005 hurricane season are now operating at even lower capacity utilization levels now. Spare capacity at existing facilities should be sufficient to satisfy new gas production for many years, although there remains a slim chance that a new gas processing facility may be needed by the end of the 40-year life of a CPA proposed action (Dismukes, official communication, 2011d). Any additions to, or expansions of, current facilities would also support State oil and gas production and, should any occur, the land in the analysis area is sufficient to handle development. Thus, the results of OCS and State oil and gas activities are expected to minimally alter the current land use of the area.

Service base infrastructure supports offshore petroleum-related activities in both OCS and State waters. Any changes to offshore support infrastructure that occurs in the cumulative case are expected to be contained on available land. Service bases are industrial ports and are located in designated industrial parks designed with the intent to accommodate future oil and gas needs. Also, most of these are located in BOEM analysis areas that have strong industrial bases. Shore-based OCS and State servicing is expected to increase in the ports of Port Fourchon, Louisiana, and Mobile, Alabama, for the CPA. There is sufficient land designated in commercial and industrial parks and adjacent to the Mobile port area. This would minimize disruption possible from port expansions to current residential and business use patterns. In contrast, while Port Fourchon has land designated for future expansion, the port has a limited amount of waterfront land available and, because of surrounding wetlands, may face capacity constraints in the long term. Port Fourchon serves as the primary support base for over 90 percent of existing deepwater projects (The Greater Lafourche Port Commission, 2011). From 2008 through 2009, the demand for support base facilities continued to increase despite an economic recession. Prior to the DWH event, new facilities at the port were leased as soon as they could be constructed (Redden, 2009).

In the months following the DWH event and the May 2010 drilling suspension, port tenants were struggling with the drop in exploration drilling. Even after the drilling suspension was lifted on October 12, 2010, activity levels remained depressed. This was due to more stringent Federal enforcement, industry's efforts to fulfill new safety requirements, and the current pace for drilling application approvals. Cleanup and decontamination work was keeping companies busy, but this has been gradually declining, with the exception of continued cleanup at Fourchon Beach, which has been slowed down by piping plover nesting. Deepwater exploratory drilling is a huge economic driver for jobs, investments, vessels, etc. at Port Fourchon (Chaisson, official communication, 2011). There has been much uncertainty about what is going to happen at Port Fourchon from an economic standpoint. However, BOEM expects this uncertainty to be short term and, because the economic prospectivity of the Gulf has not changed, deepwater activity at the port will be expected to gradually increase to pre-DWH event levels.

LA Hwy 1 is the only highway connecting Port Fourchon with the rest of Louisiana. This two-lane highway is surrounded by marshland and has been prone to extreme flooding over the years, jeopardizing critical access to Port Fourchon, which is the service base for 90 percent of OCS deepwater activity. While, in the absence of planned expansions, LA Hwy 1 would not be able to handle future OCS and State activities, a multiphase LA Hwy 1 improvement project is currently underway. On July 8, 2009, the new LA Hwy 1 fixed-span toll bridge over Bayou Lafourche connecting Port Fourchon and Leeville, Louisiana, was opened and marks partial completion of the first phase of improvements to LA Hwy 1 (*Toll Roads News*, 2009). A large portion of the tolls collected would be paid by transportation activities associated with OCS oil- and gas-related activities. The remaining portion of Phase 1 construction, a two-lane elevated highway from the bridge to Port Fourchon, is scheduled for completion in December 2011. There are continuing efforts to get Federal funding to construct Phase 2 of the project—an elevated highway from the Golden Meadow floodgates to Leeville, Louisiana (LA 1 Coalition, 2010b).

The South Lafourche Leonard Miller Jr. Airport opened a partial parallel taxiway and the Port commission has plans to extend it to full length. In the past several years, $20 million have been invested in the airport for improvements that include the paving of airport roadways, runway expansion and overlay, installation of fuel tanks, and construction of an extra-large hanger. The runway expansion and overlay have increased the maximum aircraft weight to allow access by 20-passenger jets. From 2008 to 2009, activity at the airport increased 19 percent. Airport authorities are also in the second phase of implementing an Instrument Landing System like those found at major commercial airports as a navigational aid to pilots. The Greater Lafourche Port Commission recently acquired 1,200 ac (485 ha) of property near the airport and intends to develop that land into an industrial park (The Greater Lafourche Port Commission, 2010).

If the service base expansion occurs in the cumulative case at the port of Mobile, Alabama, this expansion would occur in areas that are already industrialized and would have little effect on land use and infrastructure. This is also true for Port Fourchon, Louisiana, although, in the cumulative case, expansion of this service base may eventually be constrained by surrounding wetlands. Limited highway access and airport capacity could also constrain service base expansion at Port Fourchon in the cumulative case. However, ongoing and planned improvement projects make this unlikely.

Summary and Conclusion

Activities relating to the OCS Program and State oil and gas production are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks to accommodate future growth in oil and gas businesses. The BOEM projects 0-1 new gas processing facilities and 0-1 new pipeline landfalls for a CPA proposed action, although this is a conservative estimate and the number is much closer to zero than to one. If a new gas processing facility or pipeline landfall were to occur, it would likely be toward the end of the 40-year analysis period (Dismukes, official communication 2011a). There may be new increase demand for a waste disposal services as a result of a CPA proposed action. Any service base expansion in the cumulative case would be limited, would occur on lands designated for such purposes, and would have minimal effects on land use and infrastructure. However, in the cumulative case it is possible that Port Fourchon expansions may eventually be constrained by surrounding wetlands. Based on the available information and current BOEM scenario projections, the cumulative impacts on land use and coastal infrastructure from OCS-related activities are expected to be minor. Therefore, the incremental contribution of a CPA proposed action to the cumulative impacts on land use and coastal infrastructure are also expected to be minor.

The coastal infrastructure supporting a CPA proposed action represents only a tiny portion of the coastal land and infrastructure throughout the CPA and Gulf of Mexico, and little change is expected to occur due to changing agricultural and extractive (e.g., lumbering, petroleum) uses of onshore land. Many non-OCS-related factors contribute substantially to the cumulative impacts to land use and coastal infrastructure, including the following: housing and other residential developments; the development of private and publically owned recreational facilities; the construction and maintenance of industrial facilities and transportation systems; urbanization; city planning and zoning; changes to public facilities such as water, sewer, educational and health facilities; changes to military bases and reserves; changes in population density; changes in State and Federal land-use regulations; and changes in non-OCS-related demands for water transportation systems and ports. Given the overwhelming contribution of these non-OCS-related factors to the cumulative impacts on land use and coastal infrastructure and the small incremental contribution of a CPA proposed action, the cumulative impacts on land use and coastal infrastructure are also expected to be minor.

4.2.1.23.2. Demographics

In light of the recent DWH event, BOEM has reexamined the analysis of demographics incorporating new information related to the baseline conditions (most notably the new Woods & Poole Economics, Inc. [2010] population projection data), the incremental population impacts of a CPA proposed action, and the impacts of accidental events. While it is too early to determine if there will be any significant long-term demographic changes as a result of the DWH event and the subsequent NMFS fishing closures and drilling suspension, and given current information on the limited employment impacts to date (**Chapters 4.2.1.19, 4.2.1.20, and 4.2.1.21.3**), BOEM anticipates that there will not be any substantial long-term population and demographic changes. However, BOEM will continue to monitor data and information as it becomes available. If there are substantial long-term employment impacts to the tourism and recreation, fishing, or energy industries in the area, there may be some out-migration from some affected areas in the region.

A CPA proposed action is projected to minimally affect the demography of the analysis area. Population impacts from a CPA proposed action are projected to be minimal (<1% of the total population) for any EIA in the Gulf of Mexico region. The baseline population patterns and distributions projected and described in **Chapter 4.2.1.23.2.1** below are expected to remain unchanged as a result of a CPA proposed action. The increase in employment discussed in **Chapter 4.2.1.23.3.2** is expected to be met primarily with the existing population and available labor force, with the exception of limited in-migration (some possibly foreign) projected for focal areas such as Port Fourchon. Accidental events associated with a CPA proposed action, such as oil or chemical spills, blowouts, and vessel collisions, would likely have no effects on the demographic characteristics of the Gulf Coastal communities. The cumulative activities are projected to minimally affect the analysis area's demography.

4.2.1.23.2.1. Description of the Affected Environment

The BOEM examines demographic and economic impacts over the 40-year life of a CPA proposed action. The limited information that is available related to the impacts of the DWH event and the subsequent NMFS fishing closures and drilling suspension is presented in **Chapter 4.2.1.23.2**. However, this information does not change the Woods & Poole Economics, Inc. baseline demographic and employment projections used to analyze the impacts of a CPA proposed lease sale and of the OCS Program, which, as explained in **Chapter 4.1.1.23.2.4**, is used for the cumulative impact analysis. The methodology BOEM uses to measure employment impacts (and subsequent demographic impacts) over the 40-year life of a CPA proposed lease sale recognizes that most of the employment that results from industry activities that result from the lease sale is not generated until 4-7 years after the sale.

Offshore waters of the WPA, CPA, and EPA lie adjacent to coastal Texas, Louisiana, Mississippi, Alabama, and Florida. The U.S. Bureau of Labor Statistics groups sets of counties and parishes into LMA's on the basis of intercounty commuting patterns. Twenty-three of these LMA's span the Gulf Coast and comprise the 13 BOEM-defined EIA's. **Table 4-34** lists the counties and parishes that comprise the LMA's and EIA's, and **Figure 4-20** illustrates the counties and parishes that comprise the EIA's. The nature of the offshore oil and gas industry is such that the same onshore impact area is used to examine activities in the WPA and CPA. First, workers commute long distances for rotations offshore that last for 2-3 weeks at a time, and there is great flexibility between where employees live and where they work offshore in the GOM. Second, industry equipment and supplies for offshore projects in both planning areas come from throughout the region. Although the same overall onshore impact areas are used to analyze sales in both planning areas, the levels of economic impacts to the different individual EIA's do vary between WPA and CPA lease sales. Across the Gulf region's EIA's, a CPA proposed lease sale is projected to have a greater employment impact than a WPA proposed lease sale (based on the MAGPLAN results), with slightly more than half of employment generated in TX-3 (which includes Houston).

The U.S. Census Bureau issued a report on coastal population trends between 1960 and 2008 and found that the population in coastline counties (parishes in Louisiana) along the Gulf of Mexico increased by 150 percent, more than double the rate of increase of the Nation's population as a whole (Wilson, 2010). This population increase coincided with a 246 percent increase in housing units from 1960 to 2008. Of the 10 most intense hurricanes to strike the U.S. coastline between 1960 and 2006, only the coastline counties affected by Hurricane Katrina (2005) had an overall decrease in population (nearly a 2% loss). The Greater New Orleans Community Data Center of the Brookings Institution examined coastal employment patterns in Louisiana prior to the DWH event and found that where residents tended to be more dispersed in their spatial distributions, jobs were often more concentrated along, or closer to, coasts (Plyer, 2010).

Tables 4-35 through 4-47 provide projections of population, employment, income, wealth, and business patterns for individual EIA's; these data were obtained from the 2011 CEDDS data provided by Woods & Poole Economics, Inc. (2010). These projections assume the continuation of existing social, economic, and technological trends at the time of the forecast. Therefore, the projections include employment associated with the OCS leasing patterns and other industry trends that were prevalent prior to the DWH event and the subsequent NMFS fishing closures and drilling suspension. However, these data still remain the best long-term forecast of regional trends for socioeconomic impact analyses of a CPA proposed action. The combined population of all EIA's increased by 6 percent between 2005 and 2010; the total Gulf Coast population in 2010 was approximately 24.5 million. In the U.S., population age structures typically reflect the presence of the baby-boom generation. In the EIA's, the largest increases from 2005 to 2010 were in the Age 50 to 64 and Age 65 and Over categories, which grew by

16 percent and 10 percent, respectively. Differences in age structure, as well as net migration, among the coastal EIA's could create variations in population growth. The highest rates of population growth between 2010 and 2040 are expected in Texas EIA's (TX-1 at 63%) and Florida EIA's (FL-1 at 54.4%), and the lowest are expected in Alabama, Mississippi, and Louisiana EIA's (LA-1 is the lowest at 18.3%).

In the EIA's, the Hispanic population increased 17.2 percent between 2005 and 2010. This group is the second largest race/ethnic group in the area, making up 27.8 percent of the area's population in 2010. The total African-American population increased 5.2 percent between 2005 and 2010. Although Asians and Pacific Islanders constitute a relatively small portion of the Gulf Coast population (3.1%), this group has experienced a growth rate of 19.5 percent between 2005 and 2010. The proportion of white population has remained fairly constant and in 2010 constitutes 51.4 percent of the area's population. These overall trends vary from one EIA to another and from one Gulf Coast State to another.

The racial and ethnic composition of the analysis area reflects both historical settlement patterns and current economic activities. For example, those areas in Texas where Hispanics are the dominant group—EIA TX-1 where they represent 81 percent of the population—were also first settled by people from Mexico. Their descendants remain, many of whom work in farming, tending cattle, or in low-wage industrial jobs. By TX-3, the size of the African-American population increases, and there is a more diversified racial mix indicating more urban and diverse economic pursuits. In Louisiana, Mississippi, Alabama, and Northern Florida (FL-1 and FL-2), African-Americans outnumber Hispanics, reflecting the dominant minority status of African-Americans throughout much of the analysis area. A more detailed discussion of minority populations in the area can be found in **Chapter 4.2.1.23.4.1.**

Table 4-48 presents the baseline population projections used to analyze the impacts of a CPA proposed action and of the OCS Program (which, as explained in **Chapter 4.2.1.23.2.4** is used for the cumulative impact analysis). As stated above, these baseline projections assume the continuation of existing social, economic, and technological trends at the time of the forecast (i.e., prior to the DWH event the subsequent NMFS fishing closures and drilling suspension). However, these data still remain the best long-term forecast of regional trends for socioeconomic impact analyses of a CPA proposed action.

4.2.1.23.2.2. Impacts of Routine Events

Background/Introduction

The addition of any new human activity, such as oil and gas development resulting from a CPA proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions. Minor demographic changes, primarily in focus areas, are projected as a result of a CPA proposed action.

Proposed Action Analysis

Population

Projected population changes reflect the number of people dependent on income from OCS-related employment for their livelihood (i.e., family members of oil and gas workers). The population projections due to a CPA proposed lease sale are calculated by multiplying the employment projections for the lease sale (**Chapter 4.2.1.23.3.2**) by the average household size of 2.59 persons from the 2010 U.S. Census (**Tables 4-78**). The BOEM estimates that, for every one person currently or projected to be employed in OCS-related activities as a result of a CPA proposed action, 1.59 persons in their household would contribute to demographic changes.

A CPA proposed action is projected to contribute to population growth marginally, usually by less than a percent in each EIA. The increase in employment is expected to be met primarily with the existing population and labor force, with some in-migration to focal areas. Economic activity, and the related population impacts, as a result of a CPA proposed action are projected to peak for each EIA in different years. For the low projection, the population is expected to grow by 22,362 persons in TX-2, TX-3, and all of the Louisiana and Florida EIA's during the peak impact year (2015). The population is expected to grow by 2,134 persons in all of the EIA's located in Alabama and Mississippi and in TX-1 during the peak impact year (2028). In the high projection, the population is expected to grow by 26,911 persons in LA-1, LA-4, TX-2, and all of the Florida EIA's during the peak impact year (2018). For the high scenario where 2028 is the peak year, population is projected to increase by 18,974 persons in LA-2, LA-3, AL-1, MS-1, and TX-1. And, for the peak year of 2015 in the high projection, TX-3 is expected to increase in population by 20,314 persons as a result of a CPA proposed action. During these years, a substantial amount of platform and pipeline installations are projected in association with a CPA proposed sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, leading to more substantial employment and population impacts.

Using the new Woods & Poole Economics, Inc. (2010) data discussed above as the baseline, BOEM recalculated the population impacts on a percentage basis. The revised numbers, mirror those for employment impacts discussed in **Chapter 4.2.1.23.3.2**. Population impacts from a CPA proposed action are expected to be minimal (less than 1% of total population) for any EIA in the Gulf of Mexico region. The increase in employment is expected to be met primarily with the existing population and labor force, with the exception of some in-migration projected to move into such focal areas as Port Fourchon.

Age

The age distribution of the analysis area as a result of a CPA proposed action is projected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed above in **Chapter 4.2.1.23.2.1** is expected to continue through the life of a CPA proposed action. A CPA proposed action is not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is projected to remain virtually unchanged as a result of a CPA proposed action. The oil and gas industry has been operating in the Gulf Coast region for over 60 years, and it is well-established and completely intermeshed with the local communities and economies. A single CPA proposed action has a negligible, if any, impact on population trends in general, or racial and ethnic composition in particular. Most of the people who may be employed as a result of a lease sale are already working in the industry. Very few new jobs are created on the basis of a single lease sale; thus, changes in population cannot be conclusively tied to a single lease sale. **Chapter 4.2.1.23.4.2**, "Environmental Justice," discusses prior industry trends and efforts to recruit Laotian refugees and Mexican migrant workers. But, given the low levels of employment and population growth and the industrial expansion projected as a result of a CPA proposed action, the racial distribution pattern described above in **Chapter 4.2.1.23.2.1** is expected to continue through the life of a CPA proposed action.

Summary and Conclusion

A CPA proposed action is projected to minimally affect the demography of the analysis area. Population impacts from a CPA proposed action are projected to be minimal (<1% of the total population) for any EIA in the Gulf of Mexico region. The baseline population patterns and distributions, as projected and described in **Chapter 4.2.1.23.2.1**, are expected to remain unchanged as a result of a CPA proposed action. The increase in employment is expected to be met primarily with the existing population and available labor force, with the exception of some in-migration projected to occur in focal areas, such as Port Fourchon.

4.2.1.23.2.3. Impacts of Accidental Events

Background/Introduction

The addition of human activity associated with an oil spill response, can affect local communities in a variety of ways. Typically, these effects are short term and in the form of a temporary influx of people and money, which can translate into changes in the local social and economic institutions. Minor to no demographic changes, primarily in projected shoreline contact areas, are projected as a result of a CPA proposed action.

Proposed Action Analysis

Accidental events may cause short-term population movements as individuals seek employment related to the event or have their existing employment displaced during the event. Such population movements are relatively small and short term. The economic impacts of an accidental event (**Chapter 4.2.1.23.3**), employment impacts to commercial fishing (**Chapter 4.2.1.18**), recreational fishing (**Chapter 4.1.1.18**), and tourism and recreation (**Chapter 4.1.1.19**) are discussed in detail within their individual sections. Therefore, accidental events associated with a CPA proposed action, such as oil or chemical spills, blowouts, and vessel collisions, would likely have no effects on the demographic characteristics of the Gulf coastal communities. This is because net employment impacts from a spill are not expected to exceed 1 percent of baseline employment for any EIA in any given year even if they are included with employment associated with routine oil and gas development activities associated with a CPA proposed action and if population changes are derived from employment changes.

In the case of a catastrophic spill, there may be some out-migration from some affected areas in the region if there are substantial long-term employment impacts to the tourism and recreation, fishing, or energy industries in the area. For further discussion on the employment and demographic impacts of a catastrophic spill, see **Appendix B**.

Summary and Conclusion

Accidental events associated with a CPA proposed action, such as oil or chemical spills, blowouts, and vessel collisions, would likely have no effects on the demographic characteristics of the Gulf coastal communities, because accidental events typically cause only short-term population movements as individuals seek employment related to the event or have their existing employment displaced during the event and net employment impacts from a spill are not expected to exceed 1 percent of baseline employment for any EIA in any given year.

4.2.1.23.2.4. Cumulative Impacts

Background/Introduction

The cumulative analysis considers the effects of OCS-related, impact-producing factors as well as non-OCS-related factors on demographics. The OCS-related factors consist of population and employment from prior, current, and future OCS lease sales. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity in State waters, and offshore LNG activity. Not considered in this analysis are the unexpected events that may influence oil and gas activity within the analysis area that cannot be predicted with reasonable accuracy. Examples of unexpected events include oil embargos and acts or war or terrorism.

Most approaches to analyzing cumulative effects begin by assembling a list of “other likely projects and actions” that will be included with a CPA proposed action analysis. However, no such list of future projects and actions could be assembled that would be sufficiently current and comprehensive to support a cumulative analysis for all 132 of the coastal counties and parishes in the analysis area over a 40-year period. Instead, this analysis uses the economic and demographic projections from Woods & Poole Economics, Inc. (2010) as a reasonable approximation to define the contributions of other likely projects, actions, and trends to the cumulative case. These projections include population associated with the continuation of current patterns of OCS leasing activity as well as the continuation of trends in other industries important to the region. The same methodology used to project changes to population from routine activities associated with a CPA proposed action is used to examine impacts of the OCS Program in the region.

Population

Population impacts from the OCS Program (**Table 4-50**) are projected to be minimal, less than 1 percent to the population level in any of the EIA’s. Projected population changes reflect the number of people dependent on income from oil- and gas-related employment for their livelihood (i.e., family members of oil and gas workers). Activities associated with the OCS Program are projected to have minimal effects on population in most of the EIA’s. Three EIA’s in Louisiana (LA-1, LA-2, and LA-3), in particular, are projected to experience noteworthy increases in population resulting from increases in demand for OCS labor.

Using the new Woods & Poole Economics, Inc.'s data (2010) discussed above as the baseline, BOEM recalculated the population impacts of the OCS Program on a percentage basis. These revised numbers mirror those discussed for OCS Program employment in **Chapter 4.2.1.23.3.2**.

Age

Cumulative activities are projected to leave the age distribution of the analysis area virtually unchanged. Given both the low levels of population growth and the industrial expansion associated with the cumulative activities, it is projected that the age distribution pattern discussed above in **Chapter 4.2.1.23.2.1** would likely continue throughout the analysis period.

Race and Ethnic Composition

Cumulative activities are projected to leave the racial distribution of the analysis are virtually unchanged. Given the low levels of employment and population growth and the industrial expansion projected for the cumulative activities, the racial distribution pattern discussed above in **Chapter 4.2.1.23.2.1** is projected to continue throughout the analysis period.

Summary and Conclusion

The cumulative activities are projected to minimally affect the analysis area's demography. Baseline patterns and distributions of these factors, as described in **Chapter 4.2.1.23.2.1**, are not expected to change for the analysis area as a whole. Lafourche Parish (EIA LA-3), including Port Fourchon, and Lafayette Parish (EIA LA-2) in Louisiana are projected to experience noteworthy impacts to population as a result of an increase in demand for OCS labor from the OCS Program. A CPA proposed action is projected to have an incremental contribution of less than 1 percent to the population level in any of the EIA's, in comparison to other factors influencing population growth, such as the status of the overall economy, fluctuations in workforce, net migration, and changes in income. Given both the low levels of population growth and industrial expansion associated with a CPA proposed action, it is expected that the baseline age and racial distribution pattern would continue through the analysis period.

4.2.1.23.3. Economic Factors

This chapter examines the potential impacts of a CPA proposed action on the economies in the coastal zone of the Gulf of Mexico. The BOEM has defined EIA's that are the basis for producing statistical estimates of the employment impacts of a CPA proposed action. The BOEM uses the mathematical model MAG-PLAN to create estimates of the employment that could be generated by a CPA proposed action, as well estimates of employment that are supported by the broader OCS Program. This chapter also discusses the impacts of the DWH event on the economies of the Gulf of Mexico, as well as the lessons the DWH has taught regarding the impacts of oil spills on affected economies. However, given the modest scale of a CPA proposed action relative to the existing OCS Program, the economic impacts of a CPA proposed action are expected to be fairly small.

4.2.1.23.3.1. Description of the Affected Environment

This chapter presents information on the structure of the economies along the Gulf Coast that could be affected by a CPA lease sale. The first section describes how BOEM defines the areas that could be economically impacted by OCS activities. The first section also describes the economic structure of these areas, as well as how this structure is projected to evolve during the years in which the economic impacts of a lease sale would be most felt. The second section provides additional information regarding the economic significance of the offshore oil and gas industry in the Gulf of Mexico. The final section discusses how the DWH event and the subsequent slowdown in permit issuances have impacted the economies of the Gulf Coast.

Description of Gulf Coast Economies

Offshore waters of the WPA, CPA, and EPA lie adjacent to coastal Texas, Louisiana, Mississippi, Alabama, and Florida. The U.S. Bureau of Labor Statistics groups sets of counties and parishes into LMA's on the basis of intercounty commuting patterns; 23 of these LMA's span the Gulf Coast. The BOEM has defined 13 EIA's that are combinations of Gulf Coast LMA's. **Table 4-34** lists the counties and parishes that comprise the LMA's and EIA's, and **Figure 4-20** illustrates the counties and parishes that comprise the EIA's. The nature of the offshore oil and gas industry is such that the same onshore economic impact areas are used to examine leasing activities in both the CPA and WPA. This is because workers commute long distances for rotations offshore that last for 2-3 weeks at a time and because there is great flexibility between where employees live in the region and where they work offshore in the GOM. In addition, industry equipment and supplies for offshore projects in the CPA and WPA come from throughout the region. Although the same overall economic impact areas are used to analyze sales within the CPA and WPA, the levels of economic impacts to the different individual EIA's do vary between CPA and WPA sales. The BOEM examines economic impacts over the 40-year life of a CPA proposed action. Available information that is related to the short-term impacts of the DWH event and the drilling suspension is presented at the end of this section. However, this supplemental information does not change the Woods & Poole Economics, Inc. baseline employment projections used to analyze the impacts of a CPA proposed action and of the OCS Program; the projected economic impacts of a CPA proposed action are discussed in **Chapter 4.2.1.23.3.2**, while the projected economic impacts of the total OCS Program are discussed in **Chapter 4.2.1.23.3.4**. The methodology BOEM uses to measure employment impacts (and subsequent demographic impacts) over the 40-year life of a CPA proposed lease sale recognizes that most of the employment that results from a CPA proposed lease sale is not generated until 4-7 years after the lease sale.

Tables 4-35 through 4-47 provide projections of employment, income, wealth, and business patterns for individual EIA's; these data were obtained from the 2011 CEDDS data provided by Woods & Poole Economics, Inc. (2010). Average annual employment growth rates projected from 2010 to 2040 range from a low of 1.03 percent for EIA MS-1 to a high of 2.04 percent for EIA FL-1 in the western panhandle of Florida. Over the same time period, employment for the United States is expected to grow at about 1.39 percent per year, while the GOM economic impact analysis area as a whole is expected to grow at about 1.79 percent per year.

The Woods & Poole Wealth Index is a measure of relative wealth, with the U.S. having a value of 100. The Wealth Index is the weighted average of regional income per capita divided by U.S. income per capita (80% of the index), plus the regional proportion of income from dividends/interest/rent divided by the U.S. proportion (10% of the index), plus the U.S. proportion of income from transfers divided by the regional proportion (10% of the index). Thus, relative income per capita is weighted positively for a relatively high proportion of income from dividends, interest, and rent, and negatively for a relatively high proportion of income from transfer payments. In 2010, all EIA's within the GOM analysis area except FL-4 (which had an index of 113.4) ranked below the U.S. in terms of the Wealth Index. The next two highest EIA's were LA-4 and TX-3, with indices of 91.9 and 87.4, respectively. The EIA FL-2 ranked the lowest of all EIA's, with an index of 66.8. The Florida EIA's comprise the portion of the analysis area that is least influenced by OCS development. The EIA's with the next lowest wealth indices are AL-1 and MS-1, with indices of 71.9 and 73.6, respectively. Of the 132 counties that comprise the GOM region's economic analysis area, 19 have a higher Wealth Index than the U.S. average (6 in FL-4; 4 in LA-4; 3 in TX-3; 2 in LA-1; and 1 in LA-2, TX-1, FL-1, and FL-3). Monroe County in FL-4 was the highest, with an index of 157.91. The lowest county is Starr County in TX-1 with an index of 42.12, followed by Greene County in MS-1 with 50.92 and Hamilton County in FL-2 with 51.76.

As shown in **Tables 4-35 through 4-47**, the industrial compositions of the EIA's are similar. In 2010, all of the EIA's had State and Local Government and Retail Trade as one of their top five ranking sectors in terms of employment, and all of them except MS-1 had Health Care and Social Assistance as one of their top five. Accommodation and Food Services is one of the top five sectors for seven of the EIA's (TX-1, LA-1, LA-3, LA-4, MS-1, FL-1, and FL-2).

As part of its economic impact analysis in **Chapter 4.2.1.23.3.2 and 4.2.1.23.3.4**, BOEM uses regional input-output multipliers from the commercial software IMPLAN. A set of multipliers is created for each EIA in the analysis area based on each EIA's unique industry make-up. An assessment of the change in overall economic activity for each EIA is then modeled as a result of the expected changes in economic activity associated with holding a CPA proposed lease sale. **Table 4-51** presents the baseline employment projections used to analyze the impacts of a CPA proposed action and of the OCS Program. These baseline projections assume the continuation of existing social, economic, and technological trends at the time of the forecast. Therefore, the projections include employment associated with the OCS leasing patterns and other industry trends that were prevalent prior to the DWH event and the subsequent drilling suspension. However, these data still remain the best long-term forecast of regional trends for socioeconomic impact analyses of a CPA proposed action.

Economics of the Offshore Oil and Gas Industry

The projected economic impacts of a CPA proposed action and of the projected overall OCS Program are discussed in **Chapters 4.2.1.23.3.2 and 4.2.1.23.3.4**. However, this section and the following section discuss the current state of the offshore oil and gas industry.

Quest Offshore (2011) provides a broad overview of the economic impacts of the offshore oil and gas industry in the Gulf of Mexico. In 2009, offshore oil and gas operations in the Gulf of Mexico led to $26.9 billion in direct spending throughout the United States. The majority of this spending occurred in Louisiana ($8.6 billion) and Texas ($8.0 billion). Fifty-three deepwater projects contributed $12.7 billion in spending, while 27 shallow-water projects contributed $14.2 billion in spending. A total of $17.2 billion was spent on routine operations, while $9.7 billion was spent on equipment and machinery. Quest Offshore (2011) estimates that this spending supported approximately 80,000 jobs directly in the oil and gas industry. Using input-output modeling techniques, they estimated that approximately 285,000 jobs throughout the U.S. economy were supported by offshore oil and gas activities in the Gulf of Mexico. Quest Offshore also found that all of these economic measures of the OCS industry in the Gulf of Mexico fell noticeably in 2010. For example, total spending fell to $26.1 billion, capital investment spending fell to $6.5 billion, and total employment supported by the OCS industry fell to 242,000. However, this study also suggests that the OCS industry could rapidly recover in upcoming years, although this will depend greatly on the degree to which permitting returns to levels experienced prior to the DWH event.

IHS Global Insight (2011) also provides estimates of the economic significance of the offshore oil and gas industry in the Gulf of Mexico. This study estimated that 90,000 direct jobs, 120,000 indirect jobs, and 170,000 induced jobs were supported by the offshore oil and gas industry in the Gulf of Mexico in 2009. The differences between the employment estimates of Quest Offshore (2011) and IHS Global Insight (2011) are likely primarily due to differences in their economic modeling techniques. IHS Global Insight (2011) estimates that the offshore oil and gas industry contributed $19 billion to government revenues (including revenues from Federal taxes, State taxes, and royalty payments). The revenues generated by the OCS Program may be used to support local government functions (such as education) and are particularly important for counties/parishes whose economies depend on the OCS industry (such as Lafourche Parish). This study also provides insights regarding the relative economic significance of activities conducted by independent firms relative to the activities of the large, major oil and gas firms. They estimate that activities conducted by independent firms accounted for 203,000 jobs in 2009, while activities conducted by the major firms accounted for 180,000 jobs. IHS Global Insight (2011) also forecasts that the percentage of jobs supported by independent firms will increase from 53 percent in 2009 to 58 percent by 2020. Mason (2009) provides estimates of the total economic value of all OCS oil and gas resources in each U.S. coastal state. For example, this study estimates that Louisiana has $3.5 trillion and Texas has $1.6 trillion of total resources available to be recovered in future years. This study also provides additional information of some of the benefits that arise from the OCS Program. For example, this study elaborates on the economic stimulus effect of the OCS Program, which is particularly relevant during the period of high unemployment that has existed in recent years.

Deepwater Horizon Event

The DWH event had various economic effects along the Gulf Coast. Some of the most immediate effects were felt in the tourism and fishing industries. The DWH event led to immediate closures of beach areas and fishing sites along the Gulf Coast. A more detailed discussion of the impacts of the DWH event on these individual industries is presented in **Chapters 4.2.1.19.3, 4.2.1.20.3, and 4.2.1.21.3**. The DWH event also led to a number of impacts to the broader economy. A number of these economic impacts arose due to the deepwater drilling suspension that lasted from July 12, 2010, to October 12, 2010. The suspension had the effect of suspending activity at all 33 rigs developing exploratory wells in deep water. This posed new hardships for hundreds of oil-service companies that supply the steel tubing, engineering services, drilling crews, and marine-supply boats critical to offshore exploration

Greater New Orleans, Inc. (2011) analyzes the economic impacts of the drilling suspension on the economy of Louisiana. This study generally finds that the suspension did not immediately trigger large-scale worker layoffs. Rather, businesses generally chose to retain workers on payroll in the hope that drilling activity would resume following the lifting of the suspension. However, the payroll numbers do not take into account the loss in pay and benefits some workers experienced during the suspension. In addition, the suspension caused a good deal of financial strain to businesses as they depleted savings to cover their costs during the suspension. Finally, this study concludes that this situation was not sustainable and thus, the longer that drilling activity remained low, the more likely it would be that a larger number of layoffs would occur.

The suspension was lifted on October 12, 2010, and new permits for deepwater drilling have been awarded. Thirty-four unique wells that require subsea containment capabilities had been permitted by the end of August 2011 (Greenberg, 2011a). At the end of July 2011, 12 of 23 semisubmersibles were working and 6 of 11 drillships were working (Greenberg, 2011b). Day rates for large, deepwater supply vessel operators dropped from an average $12,830 a day in March 2010 to $10,120 in August 2011, and utilization fell from 94 percent to 83 percent over the same time period (WorkBoat.com, 2011). The pace at which industry activity will normalize will largely depend on the pace at which permit issuance occurs in upcoming months. In addition, the offshore industry also continues to face compliance with new regulations and higher insurance costs, and these may potentially lead to lower levels of industry activity than prevailed prior to the DWH event. More information on the regulatory requirements that have been implemented following the DWH event can be found in **Chapter 1.3.1**.

Table 4-52 presents monthly data on the overall unemployment rates in the major metropolitan areas along the Gulf Coast during 2010; **Table 4-52** also presents national and State unemployment rates for the same months (U.S. Dept. of Labor, Bureau of Labor Statistics, 2011). These data should provide a sense of the impacts of the DWH event on the overall economies along the Gulf Coast. In general, the unemployment rates in most areas did not dramatically change following the DWH event. Some areas, particularly in Louisiana and Florida, did see modest increases in their unemployment rates. However, since these data are not seasonally adjusted, it is difficult to disentangle the effects of the DWH event from the usually seasonality in the economies along the Gulf Coast.

The economic impacts of the DWH event have been mitigated to some extent by damage claims payments from the Gulf Coast Claims Facility (GCCF). As of March 5, 2012, the GCCF has paid approximately $6 billion to affected individuals and businesses. The GCFF has paid $2.48 billion in Florida, $1.74 billion in Louisiana, $982 million in Alabama, $445 million in Mississippi, and $237 million in Texas (Gulf Coast Claims Facility, 2012). However, the GCCF was not accessible to certain classes of workers. For example, damages due to the drilling suspension, as well as other damages that were too indirectly linked to the DWH event, were not covered by the GCCF. Shallow-water rig workers were hit particularly hard by the suspension since, unlike their deepwater counterparts, they are ineligible for the $100 million Rig Worker Assistance Fund established by BP and administered by the Baton Rouge Area Foundation. While there was no suspension of shallow-water drilling, permits for shallow-water drilling dropped in the immediate aftermath of the spill as new regulations were put in place and as operators had to adjust to these regulations. Impacts to shallow-water drillers may have been aggravated by the fact that these rigs typically operate on shorter contracts than do deepwater rigs (and are thus may lose their income streams more quickly in light of external events that reduce the demand for drilling activities).

To date, Federal, State, and local governments are also faring far better than forecasted, largely because of massive cleanup spending, according to Moody's Investor Service (Connor, 2010). Moody's had named 59 debt issues that might have been affected by the oil disaster, which had raised fears that populations might decline and that local property values and tax revenue would be decreased. Moody's reports that its analysts had determined that vital government revenue, such as property taxes, utility charges, and State school district funding, had broadly held up and that the fiscal pressures have been manageable and are not likely to be of a long-term nature (Connor, 2010).

While the effects of the DWH event are difficult to disentangle from the effects of the suspension, these effects will likely be concentrated in coastal oil-service parishes in Louisiana (St. Mary, Terrebonne, Lafourche, and Plaquemines Parishes) and counties/parishes where drilling-related employment is most concentrated (Harris County, Texas [Houston]; and Lafayette and Iberia Parishes, Louisiana) (Nolan and Good, 2010; U.S. Dept. of Labor, Bureau of Labor Statistics, 2010b; USDOC, 2010). The BOEM will continue to monitor Federal, State, and public data and analyses conducted on the economic and employment impacts of the spill and provide updated information as it becomes available.

Information regarding the impacts of the DWH event on the region's economy and employment is still being developed and compiled. However, while this information may be relevant, it would not be essential to a reasoned choice among alternatives. The incremental impact of a CPA proposed action would be small (<1%), even in light of how the DWH event changed the economic baseline. The expected incremental effects from a CPA proposed action would occur 3-7 years from a CPA proposed lease sale and would likely occur long after the impacts to the economy from the DWH event have diminished. In any event, the existing data indicate that the DWH event did not cause a significant change to the economic baseline, except potentially in the short term.

4.2.1.23.3.2. Impacts of Routine Events

Background/Introduction

A CPA proposed action would have economic impacts on a variety of firms along the OCS industry's supply chain. For example, a CPA proposed action would directly affect firms that are responsible for well drilling, equipment manufacturing, pipeline construction, and servicing OCS activities. The OCS activities would also impact the suppliers to those firms, as well as firms that depend on consumer spending of oil and gas industry workers. In order to estimate the scale of these effects, BOEM has developed the mathematical model MAG-PLAN, which is a two-stage model. The first stage estimates the levels of spending in various industries that arise from a particular scenario for oil and gas exploration and development. These estimates arise from a detailed analysis of the numerous activities that are needed to directly support OCS operations. The second stage estimates the impacts of oil and gas industry spending on the broader economies along the Gulf Coast. First, direct OCS industry spending will support activities further down the supply chain; these are referred to as "indirect" economic impacts. In addition, the incomes of employees along the OCS industry's supply chain will support consumer spending throughout the economy; these are referred to as "induced" economic impacts. These indirect and induced effects are estimated using the widely used economic modeling software IMPLAN. In particular, MAG-PLAN uses IMPLAN "multipliers" to compute how direct OCS spending circulates within the economy and translates into additional indirect and induced economic impacts. The MAG-PLAN has some limitations. For example, its employment estimates are not able to fully take into account the expected progression of the economy in future years. However, MAG-PLAN still provides reasonable estimates of the relative scale of the economic impacts of OCS activities. The initial version of MAG-PLAN is outlined in Manik et al. (2005). The BOEM has made a number of adjustments to MAG-PLAN in recent years. For example, BOEM has incorporated the use of a number of new technologies, such as subsea systems and FPSO units, into MAG-PLAN. The BOEM has also incorporated additional data regarding onshore support activities into the model. The BOEM's estimates of the economic impacts of a CPA proposed action are discussed in the next section.

Proposed Action Analysis

The MAG-PLAN's estimates of the employment impacts of a CPA proposed action are presented in **Tables 4-79 through 4-81**. **Table 4-79** presents results for a low-case production scenario, while **Table 4-80** presents results for a high-case production scenario. **Tables 4-79 and 4-80** present data on the average levels of annual employment, the peak-year levels of annual employment, and the cumulative levels of employment expected to arise over the 40-year life of a proposed action.. In **Table 4-79**, we see that a low-case production scenario leads to approximately 37,000 direct jobs, 23,000 indirect jobs, and 108,000 induced jobs in the Gulf of Mexico during the approximately 40-year life-cycle of OCS operations. The vast majority of these jobs would occur in Texas (79,600 jobs) and in Louisiana (66,000 jobs). There would also be employment effects in Florida (9,300 jobs), Alabama (7,700 jobs), and Mississippi (5,600 jobs). The employment effects of a CPA proposed action would average approximately 4,000 jobs per year in the Gulf of Mexico under the low-case production scenario and would peak at around 11,000 jobs. For most EIA's, employment would peak in 2015 (although employment in TX-1, MS-1, and AL-1 would peak in 2028). In **Table 4-80**, we see that the high-case production scenario would lead to 81,000 direct jobs, 49,000 indirect jobs, and 232,000 induced jobs in the Gulf of Mexico. The employment impacts would average around 9,000 jobs per year under the high-case scenario and would peak at around 21,000 jobs. It should be emphasized, however, that a portion of these estimates do not represent "new" jobs; many of these would represent new contracts or orders at existing firms that would essentially keep these firms operating at their existing levels as earlier contracts and orders are completed and filled. Thus, these estimates may overestimate the actual magnitude of new employment effects from a CPA proposed action. Similarly, one can view these numbers as the approximate amount of employment that could be lost if a proposed CPA lease sale was not held; more information on the economic impacts of the No Action Alternative can be found in **Chapter 4.2.3**. **Table 4-81** shows the percent of employment during the peak employment years as a percentage of total employment in each EIA. A CPA proposed action would primarily have employment impacts in TX-3 (0.1-0.2%), LA-1 (0.2-0.4%), LA-2 (0.3-0.5%), LA-3 (0.2-0.4%), and LA-4 (0.1-0.2%).

Summary and Conclusion

Should a CPA proposed action occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, Alabama, and Florida EIA's. This is because the demand would be met primarily with the existing population and labor force. Most of the employment related to a CPA proposed action is expected to occur in Texas (primarily in the EIA TX-3) and in the coastal areas of Louisiana. A CPA proposed action, irrespective of whether one analyzes the high-case or low-case production scenario, would not cause employment effects >0.5 percent in any EIA along the Gulf Coast.

4.2.1.23.3.3. Impacts of Accidental Events

Background/Introduction

An oil spill can have a number of effects on local economies. The most direct effects are felt in industries that depend on resources that are damaged or rendered unusable for a period of time due to a spill. For example, beach recreation, recreational fishing, and commercial fishing would be vulnerable if beach or fish resources were damaged due to an oil spill. However, for small to medium oil spills, the impacts to these activities would likely be localized and small in scale. More information on the effects of accidental events on these individual resources can be found in **Chapters 4.2.1.19.3, 4.2.1.20.3, and 4.2.1.21.3**. An oil spill could also have noticeable economic impacts if it were to impact important transportation routes or affect the operations of certain port facilities. **Chapter 3.1.2.1** discusses the various types of infrastructure along the Gulf Coast. However, the likelihood of a single oil spill shutting down an entire waterway or port facility is quite low.

The other economic effects of an oil spill are primarily determined by indirect actions or events that occur along with an oil spill. For example, an oil spill could lead to decreased levels of oil and gas industry operations. These effects would be most felt in coastal Louisiana and in Texas (primarily near the EIA TX-3) since these are the primary locations were OCS-related employment is concentrated. Plyer (2010) presents an analysis of the locations of oil and gas industry workers in Louisiana that were vulnerable to the DWH event. The direct effects of an oil spill on a particular industry would also ripple through that industry's supply chain; consumer spending by employees of these firms would also have impacts to the broader economy. Decreased levels of offshore oil and gas activities could also impact the revenue streams of the various levels of government in the impacted areas. Finally, the response and cleanup operations following an oil spill often have sizable effects to local economies. **Table 4-56** presents data on the levels of employment related to cleanup and response activities associated with the DWH event. As can be seen, over 40,000 workers were employed in these activities at the peak of the response effort. While the influx of workers to local areas can have a number of positive economic impacts, it can also cause disruptions to the normal functioning of local economies. In addition, the people and equipment that are dedicated to oil-spill-response efforts may be diverted from some existing services (such as hospitals, firefighting capability, and emergency services) available to local residents.

The DWH event also highlighted the economic risks of a catastrophic oil spill. First, the DWH event highlighted the fact that a spill that receives a high level of media attention can cause a number of indirect effects. In particular, the tourism and seafood industries can be negatively impacted in areas that are removed from the actual damage from a spill. The U.S. House of Representatives (2010) provides an overview of the effects of perceptions during the DWH event. A catastrophic spill also makes a number of firms particularly vulnerable if they are unable to substitute their customer base. The drilling suspension following the DWH event also caused problems for firms whose entire operations depend on offshore oil and gas activities (Greater New Orleans, Inc., 2011). Finally, a catastrophic spill can have broader impacts on oil prices, supply chains, and on the behavior of the macroeconomy.

Proposed Action Analysis

Figure 3-10 presents data on the probabilities of oil reaching certain parishes and counties within 10 days and 30 days of an oil spill as a result of a CPA proposed action. The counties that have a 1 percent or greater chance of being impacted by an oil spill within 10 days are Galveston, Texas (1-2%); Cameron, Louisiana (1-2%); Vermilion, Louisiana (1%); Terrebonne, Louisiana (2-3%); Lafourche, Louisiana (2-3%); Jefferson, Louisiana (1-2%); and Plaquemines, Louisiana (3-6%). The counties and parishes that have a 1 percent or greater chance of being impacted by an oil spill within 30 days are Calhoun, Texas (1%); Matagorda, Texas (2-3%); Brazoria, Texas (1-2%); Galveston, Texas (2-4%); Jefferson, Texas (1-2%); Cameron, Louisiana (2-4%); Vermilion, Louisiana (1-2%); Iberia, Louisiana (1%); Terrebonne, Louisiana (3-5%); Lafourche, Louisiana (2-4%); Jefferson, Louisiana (1-2%); Plaquemines, Louisiana (4-8%); and St. Bernard, Louisiana (1%). The impacts of a potential oil spill along these areas could be felt in the tourism, recreational fishing, and commercial fishing industries. A spill could also have impacts to the extent to which it interrupts the extensive oil and gas industry along the Texas and Louisiana coastlines. However, the impacts of small- to medium-sized spills should be localized and temporary. A catastrophic spill along the lines of the DWH event would have more noticeable impacts to the economy. However, the likelihood of another spill of this scale is quite low.

Summary and Conclusion

An oil spill can cause a number of disruptions to local economies. A number of these effects are due to industries that depend on damaged resources. However, the impacts of an oil spill can be somewhat broader if firms further along industry supply chains are affected. These effects depend on issues such as the effects of cleanup operations and the responses of policymakers to a spill. However, the impacts of small- to medium-sized spills should be localized and temporary. A catastrophic spill along the lines of the DWH event would have more noticeable impacts to the economy. However, the likelihood of another spill of this scale is quite low.

4.2.1.23.3.4. Cumulative Impacts

Background/Introduction

Projected Overall Economic Activity

Most approaches to analyzing cumulative effects begin by assembling a list of “other likely projects and actions” that would be included with a CPA proposed action for analysis. However, no such list of future projects and actions could be assembled that would be sufficiently current and comprehensive to support a cumulative analysis for all 132 of the coastal counties and parishes in the analysis area over a 40-year period. Instead of an arbitrary assemblage of future possible projects and actions, the analysis employs the economic and demographic projections from Woods & Poole Economics, Inc. (2010) to define the contributions of other likely projects, actions, and trends to the cumulative case. These projections are based on local, regional, and national trend data as well as likely changes to local, regional, and national economic and demographic conditions. Therefore, the projections include employment associated with the continuation of current patterns in OCS leasing activity as well as the continuation of trends in other industries important to the region. **Tables 4-35 through 4-47** provide projections of employment, income, wealth, and business patterns for individual EIA’s; these data were obtained from the 2011 CEDDS data provided by Woods & Poole Economics, Inc. (2010). Average annual employment growth rates projected from 2010 to 2040 range from a low of 1.03 percent for EIA MS-1 to a high of 2.04 percent for EIA FL-1 in the western panhandle of Florida. Over the same time period, employment for the U.S. is expected to grow at about 1.39 percent per year, while the GOM economic impact analysis area as a whole is expected to grow at about 1.79 percent per year.

Projected Employment due to the OCS Program

A CPA proposed action would contribute to the economic effects of the broader OCS Program. The OCS Program directly affects firms that are responsible for well drilling, equipment manufacturing, pipeline construction, and servicing OCS activities. The OCS activities also impact the suppliers to those firms, as well as firms that depend on consumer spending of oil and gas industry workers. In order to estimate the scale of these effects, BOEM has developed the mathematical model MAG-PLAN, which is a two-stage model. The first stage estimates the levels of spending in various industries that arise from a particular scenario for oil and gas exploration and development. These estimates arise from a detailed analysis of the numerous activities that are needed to directly support OCS operations. The second stage estimates the impacts of oil and gas industry spending on the broader economies along the Gulf Coast. First, direct OCS industry spending will support activities further down the supply chain; these are referred to as "indirect" economic impacts. In addition, the incomes of employees along the OCS industry's supply chain will support consumer spending throughout the economy; these are referred to as "induced" economic impacts. These indirect and induced effects are estimated using the widely-used economic modeling software IMPLAN. In particular, MAG-PLAN uses IMPLAN "multipliers" to compute how direct OCS spending circulates within the economy and translates into additional indirect and induced economic impacts. The MAG-PLAN has some limitations. For example, its employment estimates are not able to fully take into account the expected progression of the economy in future years. However, MAG-PLAN still provides reasonable estimates of the relative scale of the economic impacts of OCS activities. The initial version of MAG-PLAN is outlined in Manik et al. (2005). The BOEM has made a number of adjustments to MAG-PLAN in recent years. For example, BOEM has incorporated the use of a number of new technologies, such as subsea systems and FPSO units, into MAG-PLAN. The BOEM has also incorporated additional data regarding onshore support activities into the model.

Tables 4-57 through 4-58 present employment data using low-case and high-case estimates for OCS activities in the Gulf of Mexico (more information on the cumulative scenario can be found in **Chapter 3.1**). The peak employment levels in all EIA's combined are 141,000 in the low-case scenario and 218,000 in the high-case scenario. The peak employment levels for the entire OCS industry are primarily felt in Louisiana and in Texas (primarily in the EIA TX-3). The OCS activities will support 66,000 jobs in TX-3 in the peak employment year according to the low-production scenario and over 97,000 jobs in the high-production scenario. However, as can be seen in **Table 4-59**, the OCS industry will make up a larger fraction of the economy of south Louisiana. For example, in LA-2, under the high-case scenario, the OCS industry will support 7.7 percent of the total population while, in TX-3, the OCS industry will support 3 percent of the total population. Employment demand will continue to be met primarily with the existing population and available labor force in most EIA's. The vast majority of these cumulative employment estimates represent existing jobs from previous OCS-Program actions. The BOEM does expect some employment will be met through in-migration; however, this level is projected to be small and localized and, thus, BOEM expects the sociocultural impacts from in-migration to be minimal in most EIA's. As discussed in **Chapter 4.2.1.23.2.2**, a CPA proposed action is expected to contribute 0.5 percent or less to the employment level in each of the EIA's.

Summary and Conclusion

The cumulative impacts of a CPA proposed action would be determined by the expected path of the economy and by the expected progression of the OCS industry in upcoming years. The expected path of the overall economy is projected using the data provided by Woods and Poole, Inc. (2010). The expected economic impacts of the OCS industry in upcoming years are estimated using the mathematical model MAG-PLAN. The cumulative impacts of a CPA proposed action to the economies along the Gulf Coast are expected to be relatively small.

4.2.1.23.4. Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," which directs Federal agencies to assess whether their actions have disproportionate environmental effects on people of ethnic or racial minorities or people living below the poverty line. Those environmental effects encompass human health, social, and economic consequences. In 1997, President Clinton issued

Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks," requiring Federal agencies to identify and assess environmental health risks and safety risks of its policies, programs, and activities that may disproportionately affect children. In accordance with NEPA and the Executive Orders, BOEM must provide opportunities for community input during the NEPA process. (See **Chapter 5** for a discussion of scoping, and community consultation and coordination.)

Environmental justice is a complex issue, and although methodologies have evolved to assess whether an environmental injustice has taken place, this type of analysis still poses challenges, particularly when considering OCS leasing decisions. First, the OCS Program in the Gulf of Mexico is large and has been ongoing for more than 50 years. During this period, substantial leasing has occurred off Texas, Louisiana, Mississippi, and Alabama. The OCS lease sales occur in Federal waters 3 mi (5 km) or more from shore; thus, the resulting exploration, extraction, and production activities on leaseholds are distant from human habitation. State offshore oil and gas leases are closer to land and their petroleum-related activities in State waters are generally viewed as having a greater potential for directly impacting coastal communities. Second, most OCS sale-related impacts that potentially might affect environmental justice are indirect, arising onshore as the result of industry activities in support of OCS exploration, extraction, and production. An extensive upstream support infrastructure system exists to support offshore oil and gas and includes platform fabrication yards, shipyards, repair and maintenance yards, onshore service bases, heliports, marinas for crewboats and supply boats, pipeline coating companies, and waste management facilities. Downstream infrastructure moves hydrocarbon product to market and includes gas processing plants, petrochemical plants, transportation corridors, petroleum bulk storage facilities, and gas and petroleum pipelines. This infrastructure system is both widespread and concentrated. Much infrastructure is located in coastal Louisiana, less in coastal Texas, and less still in Mississippi's Jackson County and Alabama's Mobile County. While many fabrication and supply facilities are concentrated around coastal ports, downstream processing is concentrated more in industrial corridors farther inland (The Louis Berger Group, Inc., 2004).

This analysis identifies potential environmental justice impacts that might arise from these support activities, but they are only indirectly influenced by BOEM decisionmaking, and BOEM has no regulatory authority over them. Third, the resulting onshore support activities occur in the context of a very large and long-established oil industry. For the most part, activities generated by a new proposed lease sale occur where there are ongoing ones, and the two are virtually indistinguishable from each other or from established land-use patterns. Each industry sector and its associated impacts are often cumulative and occur within a mix of the effects of other sectors in each geographic location. Several of BOEM's past and ongoing studies (e.g., Hemmerling and Colten, 2003) seek to understand the underlying socioeconomic and potential environmental justice implications of OCS activities. Several ongoing studies also seek to understand the short- and long-term impacts of the recent DWH event (e.g., the study "Ethnic Groups and Enclaves Affected by OCS," which was launched on August 1, 2010). The BOEM will continue to seek additional information and bases the following analysis on the best information currently available.

4.2.1.23.4.1. Description of the Affected Environment

The oil and gas exploration and production industry and its associated support sectors are interlinked and widely distributed along the Gulf Coast. Offshore OCS-related industry operations within the CPA may rely on onshore facilities within the CPA, the WPA, or both. As an example, Port Fourchon in Lafourche Parish, Louisiana caters to 90 percent of all deepwater oil production in the GOM and roughly 45 percent of all shallow-water rigs in the Gulf (Loren C. Scott & Associates, 2008). While this analysis focuses on potential impacts within the CPA, the interlinked nature of the offshore industry necessitates a discussion of the WPA as well. Within the GOM economic impact areas, there are 81 counties/parishes that contain facilities, with five as the median number of facilities. For comparative purposes, counties/parishes with more than five facilities are considered to contain concentrations of facilities. Of the 81 counties/parishes, 39 include more than 5 facilities. These 39 counties/parishes are then divided into three levels of infrastructure concentration: low (6-15 facilities); medium (16-49 facilities); and high (50 or more facilities). The WPA has four high concentration counties/parishes (Harris, Galveston, Jefferson, and Brazoria Counties in Texas), and the CPA has six, five of which are located in Louisiana (Jefferson, Plaquemines, Orleans, St. Mary, and Calcasieu Parishes in Louisiana and Mobile County in

Alabama). Most of the counties/parishes with low and medium concentrations are located in Texas (WPA) or Louisiana (CPA) (Kaplan et al., 2011).

Onshore activities in support of exploration and production in the CPA (and their potential environmental consequences) are concentrated around support infrastructure such as ports, canals, heliports, repair yards, pipecoating facilities, and gas processing plants. While the coastal zone of the northern GOM is not a physically, culturally, or economically homogenous area, some communities within its boundaries warrant an environmental justice lens (Gramling, 1984a). The USEPA guidelines suggest different thresholds for determining whether a community or local population should be considered an environmental justice population. The BOEM focuses on counties/parishes and census tracts with high or medium concentration of OCS-related infrastructure and defines minority populations as those counties/parishes with a higher percentage of their population that is minority relative to their respective State averages. Because U.S. Census data aggregated at the county/parish level are very broad, this environmental justice analysis also considers population distributions at the smaller, more detailed census tract level to assess relationships between OCS leasing effects and geographic distributions of minority populations.

Environmental justice maps (**Figures 4-26 through 4-35**) display the location of oil-related infrastructure and the distribution of low-income and minority residents across GOM counties and parishes based on U.S. Census data from 2010 and a BOEM-funded study on Gulf Coast OCS infrastructure. Ten counties/parishes are considered to have a high concentration (50 facilities or more) of oil-related infrastructure (**Table 4-60**). Of these 10 counties/parishes, 6 are located in the CPA; of those, 3 have higher minority percentages than their respective State averages, i.e., there are 41 percent minority residents in Mobile County, Alabama; 44 percent minority residents in Jefferson Parish, Louisiana; and 43 percent minority residents in St. Mary Parish, Louisiana. **Figures 4-30 through 4-35** display maps of census tracts within Louisiana, Mississippi, Alabama, and Florida that are overlayed with a map of OCS infrastructure. There are 1,321 census tracts within the CPA economic impact area with minority populations greater than 50 percent, and of these, most are concentrated in urban centers like Mobile, Alabama; New Orleans, Louisiana; and Miami, Florida. Some of these counties/parishes also boast a high density of OCS-related infrastructure. Jefferson Parish, Louisiana, ranks second in terms of concentration of OCS-related infrastructure with 1 petrochemical plant, 46 terminals, 8 ship yards, and 6 platform fabrication facilities among other infrastructure types (Kaplan et al., 2011).

A BOEM-funded study using the 2000 Census and a weighting scheme to identify counties with heavy concentrations of OCS infrastructure identified a dozen areas within Jefferson Parish where African Americans make up more than 75 percent of the population. The analysis found a visual correlation between the concentration of black population and OCS-related infrastructure along the Harvey Canal.

Thirteen counties/parishes in the analysis area are considered to have a medium concentration (16-49 facilities) of oil-related infrastructure. Of these 13 counties/parishes, 10 are located in the CPA; of those, 3 have higher minority populations than the State average, i.e., Hillsborough County in Florida and Orleans and St. James Parishes in Louisiana (Kaplan et al., 2011).

The population of metro New Orleans declined 11 percent since 2000 (140,845 residents in Orleans Parish alone), largely reflecting the significant job losses associated with Hurricane Katrina and the recession. The percentage of black population fell to 60.2 percent from 67.3 percent.

Poverty is defined by the Office of Management and Budget's Statistical Policy Directive 14 and the U.S. Census using a set of money income thresholds that vary by family size and composition. The official poverty thresholds do not vary geographically, but they are updated for inflation using the Consumer Price Index (U.S. Census). Tract-level household income data from the 2010 Census are not yet available, and this analysis uses the 2009 Community Survey on a county/parish level basis as a placeholder. Only one parish, St. Mary Parish, out of the six CPA high infrastructure concentration counties/parishes has a higher poverty rate than its respective State poverty rate, with 18 percent of the parish living below the poverty line compared with the State's 17.6 percent average. Four parishes (Iberia, Orleans, St. Bernard, and Vermilion) out of the 10 CPA medium infrastructure concentration counties/parishes had higher poverty rates than their respective State's poverty rate. In the Eastern Research Group's study, which uses a smaller level of geographic analysis, they found five areas in Jefferson Parish, Louisiana, where more than half the population had an income below the poverty level clustered in the northern part of the parish. In Orleans Parish, using 2000 data, there was not much visual correlation between areas of high poverty and OCS infrastructure with the possible exception of one repair facility to the west of New Orleans.

Baseline Post Hurricanes and Post-*Deepwater Horizon* Event

Whether a proposed lease sale occurs within the CPA or WPA, oil and gas exploration and production activities will rely on an established network of support and processing facilities and associated labor force within both the onshore CPA and WPA. As a result, a baseline change within the WPA could potentially alter the relative risks of a lease sale in the CPA. Therefore, where appropriate, this discussion will consider recent baseline changes in the WPA. On August 29, 2005, Hurricane Katrina made landfall on the Gulf Coast between New Orleans, Louisiana, and Mobile, Alabama. Hurricane Katrina had differential impacts on the Gulf Coast population. Approximately half of those displaced lived in New Orleans, Louisiana, where the storm heavily impacted the poor and African Americans (Gabe et. al., 2005). The three states most affected also rank among the poorest according to the 2000 U.S. Census; Mississippi ranked second in its poverty rate, Louisiana third, and Alabama sixth. Approximately one-fifth (21%) of the population most directly affected by the storm was poor, a rate significantly higher than the national rate of 12.4 percent reported in the 2000 Census. While the 2008 hurricane season was particularly active in southeast Texas in the WPA, it also strongly affected CPA baseline conditions. Hurricane Gustav made landfall on September 1, 2008, near Cocodrie, Louisiana (Terrebonne Parish), and continued northwest across the State, resulting in 34 parish disaster declarations, which made these areas eligible for disaster assistance following the storm (*Federal Register*, 2008b). The affected coastal parishes also have high concentrations of oil-related infrastructure. Damage to Mississippi and Alabama coastal areas was less severe, but the National Weather Service reported 14 confirmed tornadoes from Biloxi, Mississippi, to Mobile, Alabama.

The DWH event in Mississippi Canyon Block 252 has raised several concerns regarding OCS activities and environmental justice. The Gulf Coast boasts several distinct ethnic, cultural, and low-income groups whose substantial reliance on the area's natural resources of the marshes, barrier islands, and coastal beaches and wetlands can make them particularly vulnerable to the direct and indirect effects of environmental impacts to coastal wetlands, marshes, barrier islands, and beaches. Besides an economic dependence on commercial fishing and oystering, coastal low-income and minority groups may rely heavily on these fisheries and on other traditional subsistence fishing, hunting, trapping, and gathering activities, to augment their diets and household incomes (see Hemmerling and Colten, 2003, for an evaluation of environmental justice considerations for south Lafourche Parish). Subsistence fishing in these regions is poorly documented but remains a potential pathway for impacts to certain populations along the Gulf Coast.. The largest sources of subsistence foods are from removals from commercial fishery catches and from activities similar to recreational harvesting. Therefore, as discussed in the commercial and recreational fisheries sections (**Chapters 4.1.1.16 and 4.1.1.17**), no impacts to subsistence uses are expected from normal industry operations, no impacts are expected from most accidental events although some impacts are possible, and significant impacts could result from a catastrophic event. Even when landloss and destruction caused by recent hurricanes have forced families to relocate, regular commuting has sustained this reliance on the natural resources of the coastal environments. While by no means a complete inventory of the minority, ethnic, and nationality groups that make up this diverse region and that are engaged in natural resource use and/or the petroleum industry, several populations of note have been identified to underscore the potential for environmental justice concerns: African Americans, Cajuns, Chitimacha, Houma, Isleños, Laotians, Mexicans, and Vietnamese.

The DWH event and subsequent fishing closures dealt an immediate blow to many CPA coastal communities and may have longer term impacts by damaging fish stocks or by undermining the Gulf Coast seafood "brand." Members of several minority and low-income groups, including among others African Americans, Cajuns, Houma, and Vietnamese, rely on the commercial seafood industry. For example, an estimated 20,000 Vietnamese fishermen and shrimpers live along the Gulf Coast; by 1990, over 1 in 20 Louisiana fishers and shrimpers had roots in Southeast Asia even though they comprised less than half a percent of the State's workforce (Bankston and Zhou, 1996). As of the spring of 2010, 30-50 percent of all commercial fishers living in the Gulf of Mexico region were Vietnamese Americans, while 80 percent of all Vietnamese Americans in the region were connected to the seafood industry (Mississippi Coalition of Vietnamese Fisherfolk and Families, 2010). Although not exclusively, African

Americans have traditionally comprised much of the fish processing and oyster shucking industries. Shucking houses, particularly, have provided an avenue into the mainstream economy for minority groups (Brassieur et al., 2000). African Americans in lower Plaquemines Parish, where Pointe a la Hache and other black towns such as Davant and Phoenix are found, have worked and subsisted on the natural resources of the regions for generations (The Louisiana Justice Institute, 2010). A representative sample of affidavits submitted to the Gulf Coast Claims Facility (responsible for administrating DWH event claims) indicates that Louisiana commercial fisherfolks customarily take home approximately 5-15 percent of their total catch for subsistence use (United Louisiana Vietnamese American Fisherfolks, 2010).

Disruptions to the oil and gas industry because of the DWH event and the subsequent deepwater suspension have also raised equity concerns. Evidence suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. Recent data from the U.S. Census confirms that a sizable workforce (a little over 17,000 workers) employed in mineral extraction live in the southeastern coastal parishes of Louisiana. One Agency study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Prior to the DWH event, "certain rural coastal parishes [were home to] more jobs in their parishes than workers [residing there], implying that Louisianans in neighboring parishes rely on these areas for their employment" (Greater New Orleans Community Data Center, 2010). Plaquemines Parish, for example, was home to close to 12,000 jobs but to only about 7,000 workers, and 11.5 percent of Terrebonne Parish's jobs were in the oil and gas industry. The long-term socioeconomic impact to low-income and minority communities because of industry uncertainty has the potential to reverberate across the region.

The DWH event is the third in a series of crises experienced by Louisiana coastal communities since 2005, and the environmental justice concerns from future events must be considered in this context. First, southeast Louisiana is losing coastal land from erosion and subsidence because of both natural processes (e.g., hurricanes) and human activities (e.g., control and diversion projects) (USDOI, GS, 2004). For example, since measurements began in 1956, 23 percent of the lands protecting the New Orleans metropolitan area from storm surges have been converted to open water (Liu, 2010). Besides the decreased hurricane and oil-spill protections, rapid landloss and habitat fragmentation has impacted the ability to make a living, and flooding has even caused abandonment of whole communities. The second crises to impact the region includes the 2005/2008 hurricane seasons, consequences of which have been discussed above. While tropical weather is normal, low-income and minority groups may bear a larger burden than the general population. An estimated 4,500 American Indians living on the southeast Louisiana coast lost their possessions to Hurricane Katrina according to State officials and tribal leaders. Cajuns were also impacted by Hurricane Katrina, and especially by Hurricane Rita, whose 20-ft (6-m) storm surges flooded low-lying communities in Cameron, Calcasieu, and other coastal parishes. Close to 90 percent of Louisiana's Vietnamese population lives in seven southern parishes: Orleans, Jefferson, East Baton Rouge, St. Mary, Vermilion, Terrebonne, and Lafourche (Bankston and Zhou, 1996). The New Orleans East Vietnamese community of Village de L'Est was almost entirely flooded by levee failures following Hurricane Katrina. The DWH event followed these hurricanes. Cumulatively, such events can reduce community resiliency and increase vulnerability to future hazards, opening them up to disproportionate affects from future catastrophic events.

Waste Management Related to the *Deepwater Horizon* Event's Waste

Oil and gas exploration and production wastes are exempt from Federal hazardous waste regulations based on USEPA standards. This exemption does not preclude more stringent State and local regulation, and USEPA recognizes that exploration and production wastes could present a human health hazard if not properly managed (USEPA, 2002). However, wastes from oil spills are not exempt, and the DWH event has raised the additional environmental justice concern as to whether or not low-income and minority groups have been disproportionately impacted by the disposal of wastes associated with the DWH event's containment and cleanup. Disposal procedures involved sorting waste materials into standard "waste stream types" at small, temporary stations and, then, sending each type to existing facilities that were licensed to dispose of them. The location of temporary sorting stations was linked to the location of containment and cleanup operations. Hence, future locations of any sorting stations would be determined by the needs of cleanup operations. However, waste disposal locations were determined by the specializations of existing facilities and by contractual relationships between them and the cleanup and containment firms. Although in the case of the DWH event, most cleanup occurred in the CPA, but disposal occurred in both the CPA and WPA. The requirements of the cleanup operations would likely determine the use of facilities both in the CPA and WPA should a future event occur. **Table 4-61** identifies the DWH waste disposal sites that received the greatest percentages of waste. **Table 4-61** displays for each site its location, the waste types it received, and in what quantities. This table also shows minority and low-income percentages, as well as the density of populations living within 1 mi (1.6 km) of each site. Argonne National Laboratory reported that there are 46 waste management facilities that service the oil and gas industry along the GOM, with 18 in Louisiana, 18 in Texas, 5 in Mississippi, 4 in Alabama, and 1 in Florida (Puder and Veil, 2006). Louisiana received about 82 percent of the DWH event's liquid waste recovered; of this, 56 percent was manifested to mud facilities located in Venice, Plaquemines Parish, Louisiana, and in Port Fourchon, Lafourche Parish, Louisiana; it was then transferred to a processing facility in Port Arthur, Texas. The waste remaining after processing was sent to deep well injection landfills located in Fannett and Big Hill, Texas. The sites located in Venice and Port Fourchon, Louisiana, and in Port Arthur, Fannett, and Big Hill, Texas, have low minority populations, but a few of these areas have substantial poverty rates relative to State and county means.

4.2.1.23.4.2. Impacts of Routine Events

Background/Introduction

The analysis of environmental justice is divided into those related to routine operations (below) and those related to oil spills (**Chapter 4.2.1.23.4.3**). **Chapter 4.2.1.23.4.1** describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities. The BOEM estimates that production from a CPA proposed action would be 0.460-0.894 BBO and 1.939-3.903 Tcf of gas, which is a marginal decrease in oil production and an increase in gas production from the last CPA proposed action.

Impact-producing factors associated with a CPA proposed action that could affect environmental justice include the following: (1) potential infrastructure changes/expansions including (a) fabrication yards, (b) support bases, and (c) onshore disposal sites for offshore waste; (2) increased commuter and truck traffic; and (3) employment changes and immigration. Possible changes/expansions/increases to any of these routine impact-producing factors of OCS activities occur in the context of the long-lived State and Federal oil and gas leasing programs and as incremental additions to a robust offshore oil and gas industry. As a result, the impacts from routine events produced by a CPA proposed action due to these factors are also incremental. Particularly in the case of potential social impacts, it is often not possible to separate out each additional new OCS Program effect from ongoing impacts because dynamic economic and political factors can influence investment decisions that, one way or another, will reverberate through many of the OCS economic impact areas. While individual lease sales have little influence on the factors causing impacts from routine events, the overall OCS leasing program may have more influence. For this reason, the factors considered in this chapter are explored in more detail in the cumulative analysis (**Chapter 4.2.1.23.4.4**).

Proposed Action Analysis

The Executive Order mandating an environmental justice analysis arose out of cases where minority and/or low-income communities disproportionately bore the environmental risk or direct burdens of industrial development or Federal actions. As discussed in **Chapter 4.2.1.23.4.1**, the OCS Program in the GOM is large and has been ongoing for more than 50 years. While the program is offshore, onshore activities related to it occur within a mix of communities whose economies are linked in various ways and at differing levels to its many industrial sectors. A CPA proposed action is expected to slightly increase employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. F**igures 4-24, 4-26, and 4-30 through 4-35** display the location of oil-related infrastructure and the distribution of minority residents across GOM counties/parishes and census tracts based on the U.S. Census from 2010. **Figures 4-28 and 4-29** display the location of oil-related infrastructure and the distribution of low-income households using data from the 2009 Community Survey. As stated in **Chapter 4.2.1.23.4.1**, pockets of concentrations of these populations adjacent to OCS-related infrastructure are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. In addition, the distribution of low-income and minority populations does not parallel the distribution of industry activity, and as such, effects of a CPA proposed action are not expected to be disproportionate (Kaplan et al., 2011).

Fabrication/shipbuilding yards and port facilities are major infrastructure types that demonstrate the interlinked nature of OCS activity within the GOM and could pose potential environmental justice risks. As mentioned earlier, CPA oil and gas exploration and production help to maintain ancillary industries within the WPA, including waste processing facilities. Over one-third (28 facilities) of the U.S. major shipbuilding yards are located on the GOM. Of these, most facilities are concentrated in a 200-mi (322-km) area between New Orleans, Louisiana, and Mobile, Alabama. The offshore oil industry relies heavily on specialized port infrastructure that specifically serves the need of the industry. Such activities as repair and maintenance of supply vessels, fabrication yards, and supply bases tend to be located in ports nearest to offshore drilling operations. Thus, the 34 OCS-related service bases in the CPA are mainly concentrated on the coast of Louisiana, with a handful located in Mississippi, Alabama, and Florida (The Louis Berger Group, Inc., 2004). Since a CPA proposed action would help to maintain ongoing levels of activity rather than expand them, it would not generate new infrastructure demand sufficient to raise siting issues. Also, prior to construction, any new OCS-related onshore facility would first be required to receive approval by relevant Federal, State, county and/or parish, and community governments with jurisdiction. The BOEM assumes that any new construction would be approved only if it were consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms. For these reasons, this EIS considers infrastructure projections only for the cumulative analysis (**Chapter 4.2.1.23.4.4**).

All material that moves to and from an offshore platform goes through an onshore service base. Although support and transport operations are spread throughout the Gulf Coast, most producing deepwater fields have service bases in southeast Louisiana and much of this goes through Port Fourchon in Lafourche Parish, Louisiana. . From 1995 to 1998, both the port's acreage and waterfront footage nearly doubled, from 211 to 417 ac (85 to 169 ha) and from 19,162 to 33,505 ft (5,841 to 10,212 m) of waterfront (Guo et al., 1998, p. 21). Port Fourchon has grown in recent decades, in large measure due to its role in servicing the deepwater OCS. The Port underwent a 400-ac (16-ha) expansion in 2008, with planned slip developments in the short-term and expansions of its Northern property in the long-term.

LA Hwy 1 is the primary north-south corridor through Lafourche Parish and is the principal transportation route for trucks entering and exiting Port Fourchon. According to the LA 1 Coalition, a nonprofit corporation working to improve LA Hwy 1, between 1991 and 1996, there were over 5,000 accidents along this largely rural two-lane highway. According to the LA 1 Coalition, LA Hwy 1's fatality rate is double that of similar highways (LA 1 Coalition, 2010c). In addition, LA Hwy 1 is the only means of evacuation for thousands of people. Approximately 35,000 people, including 6,000 offshore workers, use LA Hwy 1 for hurricane evacuations (LA 1 Coalition, 2010c). According to one study, the average daily traffic along LA Hwy 1 appears to be heavily influenced by the overall level of oil and gas activities and due to increased demand, particularly for deepwater services (Guo et al., 1998). Residents along the highway have expressed concern over LA Hwy 1's adequacy for traffic congestion, desiring improved hurricane evacuation, and emergency medical transportation routes (USDOT, Federal Highway Administration, 2004).

While local governments near the service bases have gained revenue from the increased activity within their jurisdictions, the demands for additional services and facilities resulting from oil and gas operations have sometimes exceeded growth in the revenue stream. A Federal cost share helped support the construction of the Leeville Bridge in 2009, considered the weakest link of the LA Hwy 1 system; the first segment of the improved 18-mi (29-km), two-lane Leeville opened to traffic in July 2011 (Louisiana Dept. of Transportation and Development, 2011). Funding is being secured for the section between Leeville and Golden Meadow with the eventual widening of the entire corridor to four lanes (Offshore Magazine, 2011). A proposed 27.5 mi (44.3 km) of improvements to the Port Fourchon highway system have yet to be funded, and continued growth of Port Fourchon and associated road traffic would add to an increased risk for users of and residents along the highway. As described in **Chapter 4.2.1.23.4.1**, community string settlement patterns in the area (in this case, on high ground along LA Hwy 1 and Bayou Lafourche) mean that all income groups would be affected by any increased traffic. A BOEM-funded study compared the percentage of different minority populations within an affected area with the percentage of that population for the State. Using this method, two minority populations are at greater risk. Hispanics are 1.36 times more likely to live along the transportation corridor, and Native Americans are twice as likely to live along the transportation corridor as anywhere else in the parish (Hemmerling and Colten, 2003). While the majority of OCS-related infrastructure in south Lafourche Parish is near where the Houma Indian population resides, a CPA proposed action would not significantly alter this preexisting situation. Over the last two decades, the area has been experiencing increased truck traffic and its associated effects due to increasing offshore-related activities at Port Fourchon. Since a CPA proposed action would significantly alter this preexisting situation, minority and low-income populations would not sustain disproportionate adverse effects from a CPA proposed action.

A CPA proposed action usually represents <1 percent of the total current permitted landfill capacity in the GOM economic impact area. The BOEM rules require that all waste considered hazardous be transported onshore and disposed of, which lowers the risks to the environment but increases the risk to those people living along the hazardous transportation routes (NTL 2009-G35, USDOI, MMS, 2009e). The USDOT currently recommends a default isolation distance of one-half mile around any roadway involved in a hazardous chemical fire. Argonne National Laboratory reported that there are 46 waste management facilities that service the oil and gas industry along the GOM, with 18 in Louisiana, 18 in Texas, 5 in Mississippi, 4 in Alabama, and 1 in Florida (Puder and Veil, 2006). **Chapters 4.2.1.23.1 and 3.1.2.2** discuss the limited likelihood of additional waste disposal facilities. Because a relatively small amount of waste results from a single CPA proposed action and because of the difficulty of separating out the relative contribution of all OCS waste from municipal waste in general or distinguishing the effects on nearby communities of OCS waste disposal from the disposal of other waste, this EIS addresses the marginal contribution of a CPA proposed action on waste issues as part of the cumulative analysis (**Chapter 4.2.1.23.4.4**).

Because of Louisiana's extensive oil-related support system (**Chapter 4.2.1.23.1**), that State is likely to experience more employment effects related to a CPA proposed action than are the other coastal states. See **Chapter 4.2.1.23.3** for a discussion of employment projections as a result of a CPA proposed action. As has been the case with several prior proposed actions, Lafourche Parish, Louisiana, is likely to experience the greatest concentration of these benefits. The BOEM employment projections can neither estimate the socioeconomic or ethnic composition of new employment nor identify the communities in which that employment would likely occur. Sectors such as the fabrication industry and support industries (e.g., trucking) employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and 2002b; Donato et al., 1998). Also, evidence suggests that a healthy offshore petroleum industry does indirectly benefit low-income and minority populations. For example, one Agency study in Louisiana found income inequality decreased during the 1970's oil boom and increased with the mid-1980's decline (Tolbert, 1995). Because of the expected concentration of employment effects in Lafourche Parish, it is also the only parish where the additional OCS-related activities and employment may be sufficient to increase stress to its infrastructure. For example, one study found that, because of local labor shortages in the past, employers actively recruited foreign employees including Laotian refugees and Mexican migrant workers. This trend has, in turn, applied pressure on available housing stocks within some GOM coastal communities that exhibited varying degrees of results in incorporating new residents into local communities (Donato, 2004). However, these effects arose during a time of a booming economy and high employment in general. According to BOEM estimates, a CPA proposed action would provide little additional employment growth. Instead, it would have the effect of maintaining current activity and employment levels, which is expected to have beneficial, although limited, direct and indirect employment effects to low-income and minority populations.

While a reevaluation of the baseline conditions pertaining to environmental justice was recently conducted as a result of the recent DWH event, it is yet to be seen how issues like new industry regulations and long-term biological impacts of the spill will affect minority and low-income communities residing along the CPA coast.

Summary and Conclusion

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a CPA proposed action are expected to be widely distributed and to have little impact. This is because a proposed action is not expected to significantly change most of the existing conditions, such as traffic or the amount of infrastructure. Where such change might occur is impossible to predict but, in any case, it would be very limited. Because of Louisiana's extensive oil-related support system, that State is likely to experience more employment effects related to a CPA proposed action than are the other coastal states, and because of the concentration of this system in Lafourche Parish, that parish is likely to experience the greatest benefits from employment benefits and burdens from traffic and infrastructure demand. Impacts related to a CPA proposed action on minority and low-income populations are expected to be primarily economic in nature and to have a limited but positive effect on low-income and minority populations because a CPA proposed action would contribute to the sustainability of current industry and related support services. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples adjacent to the OCS infrastructure (**Chapter 4.2.1.23.4**), a CPA proposed action is not expected to have a disproportionate effect on these populations even in Lafourche Parish.

A CPA proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.2.1.23.4.3. Impacts of Accidental Events

Proposed Action Analysis

Impact-producing factors associated with a CPA proposed action that could affect environmental justice include (1) oil spills, (2) vessel collisions, and (3) chemical/drilling-fluid spills. These factors could affect environmental justice through (1) direct exposure to oil, dispersants, degreasers, and other chemicals that can affect human health; (2) decreased access to natural resources due to environmental damages, fisheries closures, or wildlife contamination; and (3) proximity to onshore disposal sites used in support of oil and chemical spill cleanup efforts. The DWH event was an accidental event of catastrophic proportion and should be distinguished from accidental events that are smaller in scale and occur more frequently. A detailed analysis of a low-probability catastrophic event such as the DWH event may be found in **Appendix B**. Actions occurring within the CPA may impact environmental justice within the WPA, and vice versa. Facilities located on the coasts of the CPA may provide support for offshore activities on the WPA, and vice versa. Oil and chemical spills on the CPA may be carried by winds and currents to the coasts of the WPA, and vice versa. As a result, a discussion of a potential accidental event within a CPA proposed action area addresses potential impacts of accidental events to environmental justice both in the CPA and WPA.

Potential oil spills including surface spills and underwater well blowouts may be associated with exploration, production, or transportation phases of a CPA proposed action. A detailed risk analysis of offshore oil spills and coastal spills associated with a CPA proposed action is provided in **Chapters 3.2.1.5, 3.2.1.6, and 3.2.1.7**. When oil is spilled in offshore areas, much of the oil volatilizes or is dispersed by currents, so it has a low probability of contacting coastal areas. Low-income and minority populations might be more sensitive to oil spills in coastal waters than the general population because of their dietary reliance on wild coastal resources, their reliance on these resources for other subsistence purposes such as sharing and bartering, their limited flexibility in substituting wild resources with purchased ones, and their likelihood of participating in cleanup efforts and other mitigating activities.

Vessel collisions may be associated with exploration, production, or transportation activities that result from a CPA proposed action and are the most common source of OCS-related spills. **Chapter 3.2.4** provides a detailed discussion of vessel collisions. The BOEM data show that, from 2006 through 2010, there were 107 OCS-related collisions (USDOI, BOEMRE, 2011b). The majority of vessel collisions involve service vessels colliding with platforms or pipeline risers, although sometimes vessels collide with each other. These collisions often result in spills of various substances, and while most occur on the OCS far from shore, collisions in coastal waters can have consequence to low-income and minority communities. For example, on July 23, 2008, a barge carrying heavy fuel collided with a tanker in the Mississippi River at New Orleans, Louisiana. Over several days, the barge leaked an estimated 419,000 gallons of fuel. From New Orleans to the south, 85 mi (137 km) of the river were closed to all traffic while cleanup efforts were undertaken, causing a substantial backup of river traffic (USDOC, NOAA, 2008c). Downriver from the collision, cities and parishes that pull drinking water from the river (i.e., Gretna, Algiers, and St. Bernard and Plaquemines Parishes) shut their water intakes out of fear of possible treatment system contamination (Tuler et al., 2010). Not only can these types of events erode public confidence in governmental and corporate institutions, they may compromise municipal services for which low-income communities may be financially unable to find private market substitutions, interfere with people's ability to use natural resources, or even interfere with people's ability to travel to work, as in the case of this spill, which temporarily shut down ferry service between Algiers and downtown New Orleans.

These types of events may impact an entire region, but low-income and/or minority groups lacking financial or social resources may be more sensitive and less equipped to cope with the disruption these events pose. While low-income and minority populations already run the danger of being disenfranchised from a response effort and any resulting compensation for losses sustained because of an accidental event, limited English proficiency will likely create greater obstacles. The *Deepwater Horizon* Incident Command Center, which collected and distributed news and information from all Federal, State, local, and private responders, and which is as of summer 2011 (RestoreTheGulf.gov, 2011), has translations in the following languages: Cambodian, Croatian, Spanish, French, Korean, Greek, Laotian, Russian, Thai, and Vietnamese. The Gulf Coast Claims Facility website and other resources can be translated into Spanish, Laotian, and Vietnamese, and it also has utilized translators to assist limited English proficiency claimants.

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a CPA proposed action. **Chapter 3.2.5** provides a detailed discussion of chemical and drilling-fluid spills. Each year, between 5 and 15 chemical spills are expected to occur; most of these are ≤50 bbl in size. Large spills are much less frequent. For example, from 1964 to 2005, only two chemical spills of ≥1,000 bbl occurred. Dispersants are of particular concern for human health because, while dispersants are a relatively common product used to clean and control oil spills, they can evaporate from fresh crude and weathered oil and can come ashore as a result of burning oil out at sea. While additional production chemicals are needed in deepwater operations where hydrate formation is a possibility, overall spill volumes are expected to remain stable because of advances in subsea processing.

With the exception of a catastrophic accidental event, such as the DWH event, the impacts of oil spills, vessel collisions, and chemical/drilling fluid spills are not likely to be of sufficient duration to have adverse and disproportionate long-term effects for low-income and minority communities in the analysis area. As described earlier, low-income and/or minority groups lacking financial or social resources may be more sensitive and less equipped to cope with the disruption these events pose over the short term, but again, these smaller events should not have disproportionate long-term effects on low-income and minority communities.

Deepwater Horizon *Event*

While it is still too early to determine the long-term social impacts that may result from the DWH event, anecdotal evidence from media coverage and public responses to phone survey studies suggest possible trends that may demonstrate that low-income and minority communities were more sensitive to the DWH event. Impacts, such as the loss of income from the NMFS fishing closures and drilling suspensions, were partially mitigated by the GCCF and Gulf businesses' efforts to maintain payrolls. Low-income or minority communities could be more impacted if they lacked alternatives for the loss of access to subsistence resources or perform traditional activities because of NMFS fishing closures. While these impacts were concentrated in Louisiana and Alabama with regard to the DWH event, they may be indicative of expected impacts should another catastrophic spill occur in the future.

The National Center for Disaster Preparedness at the Mailman School of Public Health at Columbia University, in partnership with the Children's Health Fund, conducted a phone study (through the Marist Poll) between July 19 and July 25, 2010, of 1,203 adult residents of Louisiana and Mississippi living within a 30-minute drive from the Gulf of Mexico (Abramson et al., 2010). Survey respondents earning less than $25,000 reported having lost income as a result of the DWH event, and they were more likely than were higher earners to report physical (defined as respiratory symptoms or skin irritations) and mental health effects among themselves and their children. Black respondents were also more likely to report physical health problems both for their children and themselves as a result of the DWH event (Abramson et al., 2010). In a study of communities near the *Exxon Valdez* spill, Palinkas et al. (1992) suggest that cultural differences played an important role in the perception of the psychological damage produced by the disaster, which was related to "the cleaning work in which the people were involved and also the damage to fishing grounds, the main sustenance of these communities" (Palinkas et al., 1992). This work underscores the importance of the varying capacities of affected groups to cope with these types of events.

The GCCF Program, administered by the Federal Government's Claims Administrator Kenneth R. Feinberg, has provided data on DWH spill claimants divided by claim type, payout amount, and county/parish in which the claimant worked or originated from. The fund is the official way for individuals and businesses to file claims for costs and damages incurred as a result of the oil discharges due to the DWH event. While not organized by minority or income group, these data allow us to identify where claims are being made and to compare this with environmental justice communities of note. In **Table 4-62**, total GCCF Program claimants as of April 29, 2011, are divided by state and at what stage the claimant is within the claims process. A total of 507,965 claimants, including individuals and businesses (claimants may have one or more claim type) have filed for some kind of emergency or final payment. These claims include claims for removal and cleanup costs, real or personal property, lost earnings or profits, loss of subsistence use of natural resources, and physical injury/death directly or indirectly because of the DWH event. Many of these coastal counties and parishes contain large metropolitan centers as well as beach communities with economies based at least partially on tourism and recreation. Claimants can range from charter boat operators working out of Florida to bartenders working in downtown New Orleans. Either the direct effects of the DWH event or the indirect effects caused by altered perception were grounds for claims, if loss could be demonstrated. These figures include claimants living within the county or parish where the claim was made, claimants claiming losses while working in the county or parish where the claim was made, or both. Impacted industries may employ low-income and/or minority workers, and as a result, this analysis will consider both businesses and individuals within a parish or county because both could result in potential environmental justice consequences.

There is no observable relationship between low-income or high-minority communities and the number of claims. Generally, parishes and counties directly along the coast had a higher number of individuals and businesses claiming losses because of the DWH event. As discussed in **Chapter 4.2.1.23.4.1**, the DWH event had different impacts along the Gulf Coast. Some county and parish coastlines received oil and were host to disruptive cleanup efforts. Others only received DWH waste or were impacted economically because of fishing closures or consumer perception, which is discussed in greater detail in **Chapter 4.2.1.20**. Several high- or medium-OCS infrastructure counties/parishes of environmental justice concern had high numbers of residents, workers, or both claiming losses. Individual claimants could claim damages based on removal and cleanup costs, real or personal property, lost earnings or profits, loss of subsistence use of natural resources, physical injury or death, or other claims. In Mobile County, Alabama, the GCCF Program awarded a little over $275 million to 22,000 claimants. In Florida, 1,273 claimants were awarded close to $11 million in Miami-Dade County and 1,876 claimants were awarded close to $20 million in Hillsborough County. In Louisiana, a little over 50,000 claimants were awarded a total of $441 million in Orleans Parish; 3,362 claimants were awarded a total $115,651,040 in Plaquemines Parish; 4,082 claimants were awarded close to $60 million in St. Bernard Parish; and 3,387 claimants were awarded close to $72 million in Lafourche Parish. Harrison County, Mississippi, which encompasses Biloxi and Gulfport and is home to a 33 percent minority population, had 17,901 claimants who were awarded $204 million.

Chapter 4.2.1.23.4.1 discusses the DWH event's waste disposal system. While there are concerns about whether locations would worsen existing environmental injustices, waste disposal locations were determined by the specializations of existing facilities and by the contractual relationships between those facilities and cleanup and containment firms.

Subsistence

While users of coastal waters may trend towards the relatively affluent and because of the limited ability of low-income and minority subsistence users to acquire comparable substitutes for Gulf of Mexico natural resources, they may be particularly sensitive to an oil spill and related fishery closures. Several ethnic minority and low-income groups rely substantially on subsistence-based activities for food, shelter, clothing, medicine, or other minimum necessities of life (e.g., see Hemmerling and Colten, 2003, for an evaluation of environmental justice considerations for south Lafourche Parish). The DWH event and the resulting NMFS fishing closures interrupted access to these resources for weeks or months depending on the area. A representative sample of affidavits submitted to the GCCF (responsible for administrating DWH event claims) indicates that Louisiana commercial fisherfolks customarily take home approximately 5-15 percent of their total catch for subsistence use (United Louisiana Vietnamese American Fisherfolks, 2010).

Several thousand DWH emergency advance payments claims were filed claiming loss of subsistence use of natural resources. However, only a small portion of the claims filed were paid. Louisiana had the lion's share of claimants with 16,554 individuals claiming loss of subsistence use of natural resources, followed by Mississippi with 6,299 claims, Alabama with 4,119 claims, and Florida with 2,473 claims. (See **Table 4-62** for a more detailed State breakdown.) To qualify for emergency funds, claimants were asked to identify the specific natural resource that had been injured, destroyed, or lost as a result of the DWH event; to describe the actual subsistence use for the natural resource; and to describe to what extent the subsistence use was affected by the damaged or destroyed natural resource using documentation such as store and barter receipts showing the replacement costs claimed (Gulf Coast Claims Facility, 2010). The GCCF Program told the New Orleans newspaper, *The Times-Picayune*, that a claimant needs to "show documentation on their heritage, their history, and their having lived off the land" (Alexander-Bloch, 2010). In the Vietnamese fishing communities of Louisiana, however, these requirements have proven vague and challenging. Fishers save anywhere from 5 to 25 percent of their catch that they do not sell at the dock to feed themselves and immediate and extended family members or friends, and to contribute to community gatherings, such as weddings, church functions, local festivals, or to barter for other seafood, fruit, or vegetables (Alexander-Bloch, 2010). Following negotiations with nonprofit lawyers and community and advocates, the GCCF developed a new method for calculating subsistence claims beginning on March 28, 2011 (Hammer, 2011). The GCCF said it would use scholarly studies (such as the United Louisiana Vietnamese American Fisherfolks white paper) to determine consumption amounts of different groups of commercial fishers and so-called "true subsistence fishermen," namely affected Indian tribes like the United Houma Nation. As of April 27, 2011, a total of 40 claimants had been awarded close to $384,000. Most claimants received between $0.01 and $5,000. Subsistence fishing in these regions is poorly documented at this time, but it remains a potential pathway for impacts to certain populations along the Gulf Coast. The largest sources of subsistence foods are from removals from commercial fishery catches and from activities similar to recreational harvesting. Therefore, as discussed in the commercial and recreational fisheries sections (**Chapters 4.2.1.19 and 4.2.1.20**), no impacts to subsistence uses are expected from normal industry operations, no impacts are expected from most accidental events although some impacts are possible, and significant impacts could result from a catastrophic event.

Health

Prior research on the health effects of oil spills have focused primarily on the acute physical symptoms of cleanup workers and wildlife caretakers. Of the 38 accidents involving supertankers and resulting in large oil spills throughout the world, only seven studies on the repercussions of the exposure of spilled oils on human health have been completed. Aguilera et al. (2010) compiled and reviewed these studies for patterns of health effects and found evidence of the relationship between exposure and "acute physical, psychological, genotoxic, and endocrine effects in the exposed individuals." Acute symptoms from exposure to oil, dispersants, and degreasers include headaches, nausea, vomiting, diarrhea, sore eyes, runny nose, sore throat, cough, nose bleeds, rash, blisters, shortness of breath, and dizziness (Sathiakumar, 2010). Sathiakumar (2010) also compiled and reviewed most of post-oil spill health studies and found that hydrocarbons were below occupational safety levels and that the level of benzene did not exceed threshold limit values. It is important to note that the toxicity of dispersed oil in the environment will depend on many factors, including the effectiveness of the dispersion, mixing energy, type of oil, the degree of weathering, type of dispersant, temperature, salinity, duration of exposure, and degree of light penetration into the water column (National Academies of Science, 2005). The BTEX, the collective name for benzene, toluene, ethylbenzene, and xylenes, are the volatile aromatic compounds often found in discharges, and petroleum oils and products. In well-flushed, dispersive, and deeper water environments of the Louisiana coast, the BTEX chemical contaminant signal may be negligible as close as 50-100 m (164-328 ft) from the point of discharge (Rabalais et al., 1991a). Avens et al. (2011) analyzed airborne BTEX concentrations from the DWH event and found that 99 percent of their measurements taken prior to capping the well were lower than OSHA's permissible exposure limits for BTEX. The researchers found that the magnitude of these data was similar to measurements from ships not involved in oil-slick remediation, and they attributed the airborne BTEX concentrations that were measured during worker exposure monitoring to boat engine emissions (**Chapter 4.2.1**).

There has been concern regarding the use of the dispersants such as COREXIT 9500, which works the same way dishwashing liquid works on grease, but it is also toxic at 2.61 parts per million. The USEPA monitoring data have so far shown that the mix of Louisiana light crude oil and COREXIT 9500 was no more or less toxic than the other available alternatives, displaying no biologically significant endocrine disrupting activity, and it did not result in a presence of chemicals that surpassed human health benchmarks (USEPA, 2010g, 2010h, and 2010i). The USEPA, in coordination with the U.S. Dept. of Health and Human Services, developed benchmarks to assess potential human health risks from exposure to oil-contaminated water. Human health benchmarks are based on potential cancer and noncancer risks associated with exposure to oil-contaminated water in the Gulf. Where applicable, the benchmarks account for both skin contact and incidental ingestion of water by a child swimmer, assuming 90 hours of exposure. Health studies of possible long-term health effects from exposure to either the DWH event's oil or dispersants, such as the possible bioaccumulation of toxins in tissues and organs, are lacking and the potential for the long-term human health effects are largely unknown (although the National Institutes of Health has proposed such a study). Sathiakumar (2010) also suggests long-term studies to clarify potential genotoxic and endocrine changes.

As of November 27, 2010, the GCCF Program has received 8,638 claims for emergency advance payment for physical injury/death. Of those, 18 have been paid at a total of $14,336.50. As of April 27, 2011, 85 claimants had been paid a total of $412,494. As of the end of September 2010, U.S. poison control centers had taken 1,172 exposure calls involving physical exposure to an oil-spill-related toxin (e.g., oil, dispersant, food contamination, or other associated toxin) and 681 information calls from persons with questions about the medical impact of the DWH event. Most calls originated from the Gulf Coast States and most exposures had come via inhalation, although some were through dermal exposure. The most common symptoms included headaches, nausea, vomiting, diarrhea, throat irritation, eye pain, coughing/choking, and dizziness. Tulane University's Disaster Resilience Leadership Academy, along with the nonprofit health advocacy organization the Louisiana Bucket Brigade, conducted a door-to-door health and economic impact survey in coastal Louisiana (Jefferson, Terrebonne, St. Bernard, and Plaquemines Parishes) during the summer of 2010 (LA Bucket Brigade, 2011). While no medical tests were administered and this type of survey likely suffers from self-selection bias, it does provide a snapshot of local concerns. Surveyors asked a total of 954 people a series of questions regarding their exposure to the spill event, abnormal health symptoms, and medications sought to treat ailments. Of those surveyed, 46 percent reported believing that they were exposed to oil or dispersant, and of those, 72 percent reported experiencing one symptom. Sudden onset symptoms included nausea, dizziness, and skin irritation. The Centers for Disease Control and Prevention state that an "occasional brief contact with a small amount of oil will do no harm. However, some people are especially sensitive to chemicals, including the hydrocarbons found in crude oil and petroleum products. They may have an allergic reaction, or develop dermatitis or a skin rash, even from brief contact with oil" (Centers for Disease Control and Prevention, 2010). Also, results of National Institute of Occupational Safety and Health and OSHA monitoring indicate oil-spill-related toxins did not reach levels of concern (King and Gibbons, 2011; U.S. Dept. of Labor, OSHA, 2010a and 2010d).

Participants in the DWH "Vessels of Opportunity" program, which recruited local boat owners (including Cajun, Houma Indian, and Vietnamese fishermen) to assist in cleanup efforts, may be one of the most exposed groups. African Americans are thought to have made up a high percentage of the cleanup workforce. The OSHA released two matrices of gear requirements for onshore and offshore Gulf operations that are organized by task (OSHA). Of past oil-spill workers, uninformed and poorly informed workers were at more risk of exposure and symptoms, demonstrating the importance of education and proper training of workers (Sathiakumar, 2010). One of the most serious health hazards reported was heat; about 740 heat-related events (i.e., illnesses) were reported for workers involved in cleanup (U.S. Dept. of Labor, OSHA, 2010b).

The National Oceanic and Atmospheric Administration, the Food and Drug Administration, and State regulators have coordinated efforts to help prevent oil-tainted seafood from reaching the market. An assumption of the Food and Drug Administration's guidelines, however, is that people eat two meals of fish and one meal of shrimp per week, with no more than 3 ounces of shrimp per meal (approximately 4 jumbo shrimp). A Natural Resources Defense Council online survey of 547 Gulf Coast residents in Louisiana, Mississippi, Alabama, and Florida was conducted from August through October 2010 to assess seafood consumption rates in the Gulf coastal zone. Online survey tools generally suffer from an unknown level of selection bias; however, these numbers still provide at least a snapshot of local seafood consumption patterns, particularly for minority subsistence-reliant groups. The Asian/Pacific Islander ethnic group surveyed had an average fish consumption frequency of 5 times per week and median fish consumption frequency of 2 times per week, with some individuals reporting to eat fish 5-8 times per week (Natural Resources Defense Council, 2010). Native Americans and Asian/Pacific Islanders consumed oysters more frequently as well. The Asian ethnic group surveyed also had an average and median crab consumption frequency of 1 time per week and some respondents reporting to consuming crab 4 times per week. The Natural Resources Defense Council calculated total daily consumption rates in grams(g)/day for all respondents and found that the median daily consumption for the study as a whole was 48 g/day, respondents from Louisiana rural coastal communities was 53.3 g/day, and respondents from Vietnamese-American communities in Louisiana and Mississippi was 64 g/day. All consumption rates exceeded the Food and Drug Administration's assumptions. In Gulf coastal areas, low-income and minority groups are heavy subsistence users of local seafood. The concern is that heavy subsistence users face higher than expected, and potentially harmful, exposure rates to PAH's from the DWH event. For example, a study following the *MV Erika* spill off the coast of France, rats were fed oil-contaminated mussels daily for 2 and 4 weeks. No evidence of genotoxicity was observed in the blood samples, although significant increases in DNA damage were observed in the liver and the bone marrow of the rats. The intensity of the DNA damage increased with the PAH contamination level of the mussels (Aguilera, 2010). In the Gulf, actual levels of exposure are unknown, and the potential health effects from higher than expected exposures remain a concern (Mackar, 2010). To date, the extensive water, sediment, and seafood sampling performed by various agencies suggest low potential exposure levels (Brown et al., 2011b; Dickey, 2012; King and Gibbons, 2011; Middlebrook et al., 2011; U.S. Dept. of Labor, OSHA, 2010a and 2010d). One effort involved sampling and monitoring crabs, shrimp, and oysters. In over 250 samples, researchers found no levels of PAH's above the level of concern established by the risk assessment protocol for reopening closed fisheries that was developed by the U.S. Food and Drug Administration, NOAA, and the Gulf Coast States (Brown et al., 2011b). However, there is dispute within the scientific community over the validity of the risk assessment protocol developed by the U.S. Food and Drug Administration, NOAA, and the Gulf States. The U.S. Food and Drug Administration was criticized by some scientists who argued that the levels of concern used by the protocol significantly underestimated the risk from seafood contaminants among vulnerable populations such as pregnant women and children (Rotkin-Ellman et al., 2012; Rotkin-Ellman and Soloman, 2012). The U.S. Food and Drug Administration defended the protocol as valid (Dickey, 2012). Future long-term studies may help to resolve the dispute. For purposes of this EIS, BOEM has conservatively assumed that fish consumption remains a potential pathway for impacting the local population in the event of a large-scale spill or catastrophic event.

Summary and Conclusion

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a CPA proposed action. Low-income and minority populations might be more sensitive to oil spills in coastal waters than is the general population because of their dietary reliance on wild coastal resources, their reliance on these resources for other subsistence purposes such as sharing and bartering, their limited flexibility in substituting wild resources with purchased ones, and their likelihood of participating in cleanup efforts and other mitigating activities. With the exception of a catastrophic accidental event, such as the DWH event, the impacts of oil spills, vessel collisions, and chemical/drilling fluid spills are not likely to be of sufficient duration to have adverse and disproportionate long-term effects for low-income and minority communities in the analysis area.

An event like the DWH event could have adverse and disproportionate effects for low-income and minority communities in the analysis area. To date, there is little concrete evidence that such effects may have occurred (Brown et al., 2011b; Dickey, 2012; King and Gibbons, 2011; Middlebrook et al., 2011; U.S. Dept. of Labor, OSHA, 2010a and 2010d), although there is some dispute in the scientific community about proper risk assessement standards in seafood contamination research (Rotkin-Ellman et al., 2012; Rotkin-Ellman and Soloman, 2012). Whether or not long-term impacts to low-income and minority communities will occur is unknown. While economic impacts have been partially mitigated by employers retaining employees for delayed maintenance or through the GCCF Program's emergency funds, the physical and mental health effects to both children and adults within these communities could potentially unfold for many years. As studies of past oil spills have highlighted, different cultural groups can possess varying capacities to cope with these types of events (Palinkas et al., 1992). Likewise, some low-income and/or minority groups may be more reliant on natural resources and/or less equipped to substitute contaminated or inaccessible natural resources with private market offerings. Because lower-income and/or minority communities may live near and directly involved with spill cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects. The post-DWH event's human environment remains dynamic, and BOEM will continue to monitor these populations over time and to document short- and long-term DWH event impacts. In the future, the long-term impacts of the DWH event will be clearer as time allows the production of peer-reviewed research and targeted studies that determine those impacts.

The DWH event was a low-probability catastrophic event. For the reasons set forth in the analysis above, the kinds of accidental events (smaller, shorter time scale) that are likely to result from a CPA proposed action may affect low-income and/or minority more than the general population, at least in the shorter term. These higher risk groups may lack the financial or social resources and may be more sensitive and less equipped to cope with the disruption these events pose. These smaller events, however, are not likely to significantly affect minority and low-income communities in the long term.

4.2.1.23.4.4. Cumulative Impacts

Background/Introduction

Of all activities in the cumulative scenario, those that could potentially impact environmental justice in the CPA include (1) proposed actions and the OCS Program, (2) State oil and gas activity, (3) existing infrastructure associated with petrochemical processing including refineries and polyvinyl plants, (4) existing waste facilities including landfills, (5) coastal erosion/subsidence, (6) hurricanes, and (7) the lingering impacts of the DWH event. The context in which people may find themselves, and how that context affects their ability to respond to an additional change in the socioeconomic or physical environment, is the heart of an environmental justice analysis. The OCS Program in the GOM is large and has been ongoing for more than 50 years with established infrastructure, resources, and labor pools to accommodate it. That said, low-income and/or minority groups lacking financial, social, or environmental resources or practical alternatives may be more sensitive than other groups to the consequences of an oil spill, such as interruptions to municipal services or fisheries closures, and they may be less equipped to cope with these consequences. In studies on social disaster resiliency, variables such as income inequality can negatively impact a community's ability to respond and recover from a disaster (Norris et al., 2008). Groups may be even less so equipped to respond to these types of events if they are already in the process of recovering from a disaster, such as a hurricane. On the other hand, Cutter et al. (2008) found that previous disaster experience, defined as the number of paid disaster declarations, positively affected disaster resilience. This cumulative impact analysis examines how incremental additions to an established program from a CPA proposed action area may potentially interact with other ongoing impacts along the Gulf Coast. As explained in prior sections, the interlinked nature of the OCS industry requires a discussion of potential impacts both in the CPA and WPA.

OCS Program

A CPA proposed action and the OCS Program have the potential to adversely impact low-income, minority, and other environmental justice communities either directly or indirectly from onshore activities conducted in support of OCS exploration, development, and production (for a fuller discussion on potential impacts from routine events and accidental events, see **Chapters 4.2.1.23.4.2 and 4.2.1.23.4.3**, respectively). Potential vectors for impacts include increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic), additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste), and additional accidental events such as oil or chemical spills. The BOEM estimates that production for a CPA proposed action would be 0.460-0.894 BBO and 1.939-3.903 Tcf of gas (**Table 3-1**). **Chapter 4.2.1.23.3.1** describes the widespread and extensive OCS-support system and associated labor force, as well as economic factors related to OCS activities. The widespread nature of the OCS-related infrastructure serves to limit the magnitude of effects that a single CPA proposed action or the overall

OCS Program may have on a particular community. Future lease sales would serve mostly to maintain the ongoing activity levels associated with the current OCS Program.

For most of the Gulf Coast, the OCS Program will result in only minor economic changes. Generally, effects will be widely yet thinly distributed across the Gulf Coast and will consist of slight increases in employment and few, if any, increases in population. Some places could experience elevated employment, population, infrastructure, and/or traffic effects because of local concentrations of fabrication and supply operations. Because of Louisiana's extensive oil-related support system, that State is likely to experience more employment effects related to a CPA proposed action than are the other coastal states. Because Lafourche Parish, Louisiana, already services about 90 percent of all deepwater and 45 percent of all shallow-water oil and gas production in the Gulf, it is likely to continue experiencing benefits from the OCS Program (Loren C. Scott & Associates, 2008). Louisiana is likely to continue to experience more than do other Gulf Coast States. Except in Louisiana, the OCS Program is expected to provide little additional employment, although it will serve to maintain current activity levels, which is expected to be beneficial to Gulf region low-income and minority populations generally. Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One Agency study found income inequality in Louisiana decreased during the oil boom and increased with the decline (Tolbert, 1995).

Environmental justice often concerns infrastructure siting, which may have disproportionate and negative effects on minority and low-income populations. Since OCS lease sales help maintain ongoing levels of activity rather than expand them, no single CPA proposed action generates significant new infrastructure demand. Pipeline shore facilities are small structures, such as oil metering stations, associated with pipeline landfalls. At present, there are 129 OCS-related pipeline landfalls and 53 OCS-related pipeline shore facilities in the GOM region (**Table 3-13**). **Chapter 3.1.2** discusses projected new coastal infrastructure that may result from a CPA proposed action, including the potential need for the construction of new facilities and/or the expansion of existing facilities. Each OCS-related facility that may be constructed onshore must receive approval by the relevant Federal, State, and local agencies. Each onshore pipeline must obtain similar permit approval and concurrence. The BOEM assumes that all such approvals would be consistent with appropriate land-use plans, zoning regulations, and other Federal/State/regional/local regulatory mechanisms. Should a conflict occur, BOEM assumes that approval would not be granted or that appropriate mitigating measures would be enforced by the responsible political entities such as USEPA, the Louisiana Department of Natural Resources, and the Louisiana Department of Environmental Quality.

As stated in **Chapter 4.2.1.23.4.1**, the region as a whole is not homogenous, but there are several potentially vulnerable ethnic and socioeconomic groups, some residing in enclaves, dispersed throughout OCS Gulf of Mexico economic impact areas. It shows that the 10 counties/parishes with high concentrations of oil-related infrastructure (**Table 4-60**) are not generally those with high concentrations of minority and low-income populations and that, in these counties/parishes, many of the low-income and minority populations reside in large urban areas where the complexity and dynamism of the economy and labor force preclude measurable sale-level or programmatic-level OCS effects.

Two local infrastructure issues analyzed in **Chapter 4.2.1.23.4.1** could possibly have related environmental justice concerns: traffic on LA Hwy 1 and the Port Fourchon expansion. This analysis concludes that the minority and low-income populations of Lafourche Parish will share the negative impacts of the OCS Program with the rest of the population. However, most effects are expected to be economic and positive. It is likely that a proposed 27.5 mi (44.3 km) of improvements to the Port Fourchon highway system will be funded in the next few years, alleviating many of the associated issues with the highway.

While there is a link between a healthy oil industry and indirect economic benefits to all sectors of society, this link may be weak in some communities and strong in others, such as Lafourche Parish, Louisiana. Even in these areas, the petroleum industry has not been a critical factor in social change, except for limited periods of time Impacts, including how communities respond to fluctuations in industry activity, vary from one coastal community to the next. Expansion or contraction of offshore or onshore oil and gas activity has produced moderate impacts in some communities, whereas other communities have dealt with episodes of rapid industry change with negligible to minor impact. Furthermore, non-OCS activities, such as expansions of the tourism industry or the highway system, often can generate socioeconomic impacts by being a catalyst for such things as in-migration, demographic shifts, population change, job creation and cessation, community development strategies, and overall changes in social institutions (i.e., family, government, politics, education, and religion). This analysis concludes that the contribution of a CPA proposed action to the OCS Program's cumulative environmental justice impacts would be negligible. The analysis also concludes that, overall, OCS programmatic impacts to environmental justice over the next 40 years would likely represent a very small proportion of the cumulative impacts of all activities that affect environmental justice.

State Oil and Gas

Onshore activities conducted in support of State oil and gas exploration, development, and production have the potential to adversely impact low-income, minority, and other environmental justice communities either directly or indirectly. Louisiana, Mississippi, and Alabama jurisdiction over mineral resources extends 3 nmi (3.5 mi; 5.6 km) from the shore; Texas and Florida jurisdiction over the seabed extends out 9 nmi (10.4 mi; 16.7 km). The annual gas production from Alabama State waters has ranged from 150 to 200 Bcf or approximately 50 percent of the State's total gas production (State of Alabama, n.d.). While offshore leasing in shallow waters is in general decline, states like Louisiana are attempting to incentivize increased activity closer to the shore. In 2006, the Louisiana Legislature authorized the Louisiana Dept. of Environmental Quality to implement an Expedited Permit Processing Program, which has so far resulted in a 55 percent reduction in coastal permitting time (Louisiana Dept. of Natural Resources, 2009). In November 2010, Louisiana voters passed the Louisiana Natural Resource Severance Tax Amendment, which effectively decreases the amount of taxes retained by the State on the severance of natural resources, but it increases what can be collected by the parishes where resources are extracted (State of Louisiana, 2010). Whether this measure will increase individual parishes' incentive to encourage production closer to the coast is still unknown.

State offshore oil and gas programs pose the same potential issues as does the OCS Program, although since State leases are closer to land, their petroleum-related activities are generally viewed as having greater potential for directly impacting coastal communities. The BOEM assumes that sitings of any future facilities associated with State programs would be based on the same economic, logistical, zoning, and permitting considerations that determined past sitings. Revenues from State-water oil programs have produced several positive impacts, and the steady stream of oil exploration and development have produced positive cumulative impacts that include increased funding for infrastructure, higher incomes (that can be used to purchase better equipment for subsistence), better health care, and improved educational facilities. While industrialization generally leads to a shift in community organization and cultural development, the offshore oil and gas industry and its concentrated work schedule has been more accommodating of "traditional" activities, such as trapping and fishing, during their time at home (Luton and Cluck, 2004).

Downstream Activities

Existing onshore infrastructure associated with petrochemical processing including refineries and the production of petroleum-based goods such as polyvinyl plants poses potential health and other related risks to minority and low-income communities. Expectations for new gas processing facilities being built during the period 2012-2051 as a direct result of the OCS Program are dependent on long-term market trends that are not easily predictable over the next 40 years. Existing facilities will experiences equipment switch-outs or upgrades during this time. The marginal contribution of a WPA proposed action does not change the estimate. The geographic distribution of projected gas processing plants differs markedly from the current distribution. The BOEM cannot predict and does not regulate the siting of future gas processing plants. The BOEM assumes that sitings of any future facilities will be based on the same economic, logistical, zoning, and permitting considerations that determined past sitings and that they will not disproportionately affect minority and low-income populations. An environmental justice study of industrial siting patterns in Jefferson, St. Bernard, and Lafourche Parishes, Louisiana, (Hemmerling and Colten, 2003) found that "people appear to be moving into densely populated, largely industrial areas here the costs of rent are lower. In addition, people tend to be moving into newer housing." This historical analysis revealed little evidence of systematic environmental injustice of various oil-related industries, with the demographic makeup of the communities changing after facilities arrived.

Public Health

The Natural Resources Defense Council and the National Disease Clusters Alliance identify and track disease clusters in the U.S. An unusually large number of people sickened by a disease in a certain place and time is known as a "disease cluster"' (Natural Resources Defense Council and the National Disease Clusters Alliance, 2011). The underlying causes of a disease cluster can be genetic, environmental, or both. The State of Louisiana's Center for Environmental Health defines an environmental disease cluster when evidence of a known connection between the hazard and the disease or health outcome of concern is established (Louisiana Center for Environmental Health, 2008). The Natural Resources Defense Council and the National Disease Clusters Alliance identified disease clusters in 13 states, with four clusters in Louisiana and three clusters in Florida. The four locations in Louisiana include Mossville in Calcasieu Parish, Amelia in St. Mary Parish, Coteau in Iberville Parish, and New Orleans in Orleans Parish. The Agency for Toxic Substances and Disease Registry identified a cluster of breast cancer in an urban census tract at the Agricultural Street Landfill Superfund Site in New Orleans in a 2003 study (Natural Resources Defense Council and the National Disease Clusters Alliance, 2011). According to the Agency for Toxic Substances and Disease Registry, the site and neighborhood are contaminated with metals, PAH's, volatile organic compounds, and pesticides. From 1986 through 1987, researchers from Louisiana State University Medical School identified a cluster of neuroblastoma, a type of brain cancer adjacent to a marine shale processor plant. There was insufficient data to link a hazardous waste incinerator at the marine shale processor plant, but in 2007 the owners paid the State government a settlement to close and remediate the site. The three disease clusters in Florida were unrelated to OCS activities, but they were industrial in nature (Natural Resources Defense Council and the National Disease Clusters Alliance).

That was Due to the distance of OCS Program activities offshore, routine events related to a CPA proposed action would not be expected to affect public health in these communities. Both of these sites are far from a coastline where an OCS oil spill could directly impact these people, but it is not unlikely that members of these communities could participate in cleanup efforts. An environmental justice analysis seeks to identify populations that, through a variety of mechanisms, may become disproportionately impacted by a CPA proposed action and its associated activities. Research like this suggests that there may be a correlation between downstream oil and gas processing (after any OCS Program-related oil and gas comes ashore) and diminished health in adjacent populations. As a result, communities appearing to have disease clusters are probably more sensitive to potential impacts in a cumulative scenario.

Waste

Based on operator data provided in filed plans, BOEM estimates that there is an average of 2,000 ft^3 (57 m^3) of trash and debris generated per exploration well drilled, 102 ft^3 (3 m^3) of trash and debris generated per development well drilled, and 1,000ft (28 m^3) of trash and debris generated per year per manned platform of its 25-year life (Dismukes, 2007). A single CPA proposed action usually represents <1 percent of the total current permitted landfill capacity in the GOM economic impact area. Because of technological improvements on how waste is compacted, landfill capacity has increased, with Texas landfills having increased useful life by 19 years from the mid-1990's to 2005. Drilling muds and wastewater streams can be used as landfill cover, and landfills will often accept these materials at a reduced price or even at no charge (The Louis Berger Group, Inc., 2004). The occurrence of hazardous offshore, oil-field waste is minimal and infrequent. Industry representatives contacted for a BOEM study indicated that the need for hazardous storage could occur as infrequently as once in 5 years for a typical offshore facility with drilling and production activities (Dismukes, 2007). **Table 4-61** lists existing waste sites and the amount of waste generated by the DWH event that was distributed between Gulf landfills and waste processing facilities. Argonne National Laboratory reported that there are 46 waste management facilities that service the oil and gas industry along the GOM, with 18 in Louisiana, 18 in Texas, 5 in Mississippi, 4 in Alabama, and 1 in Florida (Puder and Veil, 2006). Because of existing capacity, no new waste disposal sites are projected for the cumulative case (The Louis Berger Group, Inc., 2004). Therefore, no changes in impacts to minority and low income communities are expected.

Coastal Erosion and Subsidence

Coastal erosion and subsidence in some parts of the southeastern coastal plain serves to amplify the vulnerability of communities, infrastructure, and natural resources to storm-surge flooding (Dalton and Jones, 2010). Submergence in the Gulf is occurring most rapidly along the Louisiana coast and more slowly in other coastal states. Depending on local geologic conditions, the subsidence rate varies across coastal Louisiana from 3 to over 10 mm/yr (0.12 to over 0.39 in/yr). Natural drainage patterns along many Texas coast areas have been severely altered by construction of the Gulf Intracoastal Waterway and other channelization projects associated with its development. Saltwater intrusion resulting from river channelization and canal dredging is a major cause of coastal habitat deterioration (Tiner, 1984; National Wetlands Inventory Group, 1985; Cox et al., 1997); see **Chapter 4.2.1.4** for a discussion of wetlands in the CPA. As discussed in **Chapter 4.2.1.23.4.4**, tropical storms are the norm in the region, but low-income and minority communities may bear a larger burden than the general populations. Native Americans, Vietnamese, Cajun, African American, and other ethnic enclaves have all borne catastrophic losses in recent storm events. An estimated 4,500 Native Americans living on the southeast Louisiana coast lost their possessions to Hurricane Katrina according to State official and tribal leaders. Cajuns were also impacted by Hurricane Katrina, and especially by Hurricane Rita, whose 20-ft (6-m) storm surges flooded low-lying communities in Cameron, Calcasieu, and other coastal parishes. According to a USGS 5-year, post-Katrina survey, wetland loss in Louisiana from all four storms (Hurricanes Katrina, Rita, Gustav, and Ike) totaled 340 mi^2 (881 km^2).

Coastal subsidence, sea-level rise, and erosion can increase community vulnerability to future hazards and also threaten traditional ways of life. Saltwater intrusion reduces productivity and species diversity associated with Louisiana and Texas wetlands and coastal marshes (Stutzenbaker and Weller, 1989; Cox et al., 1997). While users of coastal waters may trend towards the relatively affluent, low-income and minority groups may be more dependent on the resources of the Gulf Coast. Several ethnic minority and low-income groups rely substantially on these resources for food, shelter, clothing, medicine, or other minimum necessities of life (e.g., see Hemmerling and Colten, 2003 for an evaluation of environmental justice considerations for south Lafourche Parish).

Coastal Storms

Hurricanes, tropical storms, and other wind-driven tidal or storm events are a fact of life for communities living along the Gulf of Mexico coastal zone. For low-income and minority populations, however, the impacts of coastal storm events can be particularly profound because of factors like limited resources to evacuate or to mitigate hazards. Baseline conditions pertaining to environmental justice were reevaluated in light of recent hurricane activity in the GOM. The intensity and frequency of hurricanes in the Gulf over the last 7 years has greatly impacted the system of protective barrier islands, beaches, and dunes and associated wetlands along the Gulf Coast. Within the last 7 years, the Gulf Coast of Texas, Louisiana, Mississippi, Alabama, and to some degree Florida have experienced five major hurricanes (Ivan, Katrina, Rita, Gustav, and Ike). Impacts from future hurricanes and tropical storm events are uncertain. One study found that neighborhoods with higher proportions of renters, households in poverty, and minorities were more likely to have waited to evacuate the urbanized barrier island in advance of Hurricane Ike (Van Zandt, 2009). Municipal programs like the New Orleans Office of Homeland Security and Public Safety’s City Assisted Evacuation Plan are being implemented to help citizens who want to evacuate during an emergency but lack the capability to self-evacuate (City of New Orleans, 2011). Hazard mitigation funds available through individual states and FEMA also seek to mitigate potential damage to homes in flood zones throughout the Gulf. While hurricanes and tropical storms are inevitable, lessons learned from Hurricanes Katrina and Rita are shaping local and national policies as well as efforts by non-governmental organizations to protect low-income, minority, and other vulnerable communities.

Deepwater Horizon *Event*

While it is still too soon to determine the long-term social impacts of the DWH event, anecdotal evidence from media coverage and early survey studies suggest the possibility of trends that might disproportionately affect low-income and minority communities for some time to come. A phone survey conducted by a team of LSU sociologists found that nearly 60 percent of the 925 coastal Louisiana residents interviewed reported being almost constantly worried by the DWH event (Lee and Blanchard, 2010). Studies of residents near past oil spills (such as the *Exxon Valdez* in Prince William Sound, Alaska) have noted impacts to social cohesion and increased distrust in government and other institutions, which contributed to community anxiety (Tuler et al., 2009).

Cumulative effects on social organization could include decreasing importance of family, cooperation, sharing, and subsistence availability. Long-term effects on wild resource harvest patterns might also be expected. While acute health effects from oil-spill events have been somewhat studied, the long-term impacts from exposure is unknown (Aguilera et al., 2010; Meo, 2009; Morita et al., 1999; Sathiakumar, 2010). Long-term health surveillance studies of possible long-term health effects from exposure to either the DWH event's oil or dispersants, such as the possible bioaccumulation of toxins in tissues and organs, by the National Institutes of Health are ongoing. The potential for the long-term human health effects remain largely unknown. Participants in the DWH "Vessels of Opportunity" program, which recruited local boat owners (including Cajun, Houma Indian, and Vietnamese fishermen) to assist in cleanup efforts, may be one of the exposed groups. African Americans are thought to have made up a high percentage of the cleanup workforce. In Gulf coastal areas, low-income and minority groups are heavy subsistence users of local seafood. Worker and shoreline monitoring data indicate that the concentrations of oil and dispersants to which low-income and minority communities may have been exposed are unlikely to result in adverse health effects (King and Gibbons 2011; Middlebrook et al., 2011; U.S. Dept. of Labor, OSHA, 2010a and 2010d). One concern is that heavy subsistence users may face higher than expected, and potentially harmful, exposure rates to PAH's from the DWH event. However, fisheries closures may have temporarily limited access to subsistence foods, thereby also reducing the potential of oil dispersant exposure, especially since fisheries were not reopened until testing indicated that the waters were safe for fishing. Extensive seafood testing for PAH's and dispersant compounds found levels that were within the risk assessment protocol established by the U.S. Food and Drug Administration, NOAA, and the Gulf Coast States (Brown et al., 2011b; Dickey, 2012). It should be noted that there is some dispute within the scientific community over the validity of the risk assessment protocol that was used, and concern that the levels of concern established by the protocol may have underestimated the risk from seafood contaminants among vulnerable populations such as pregnant women and children (Rotkin-Ellman et al., 2012; Rotkin-Ellman and Soloman, 2012). The U.S. Food and Drug Administration defended the protocol as valid (Dickey, 2012). Future long-term studies may help to resolve the dispute. For purposes of this EIS, BOEM has conservatively assumed that fish consumption remains a potential pathway for impacting the local population in the event of a large-scale spill or catastrophic event.

As mentioned earlier, the National Institutes of Health's proposed study, known as the Gulf Long-Term Follow-Up Study, should provide a better understanding of the long-term and cumulative health impacts, such as the consequences of working close to a spill and of consuming contaminated seafood. The Gulf Long-Term Follow-Up Study will monitor oil-spill cleanup workers for 10 years. Several ongoing studies also seek to understand the short- and long-term impacts of the recent DWH event (e.g., the study "Ethnic Groups and Enclaves Affected by OCS," which was launched on August 1, 2010). Information regarding the impacts of the DWH event remains incomplete at this time. Studies regarding environmental justice concerns in light of the DWH event are only in their infancy, and it may be years before data are available and certainly not within the timeframe contemplated by this NEPA analysis. The NRDA process, which is ongoing, may help to inform issues relating to subsistence and other indigenous reliance on natural resources. This information is unavailable and unobtainable at this time, regardless of costs. In its place, subject-matter experts have used credible information that is available and applied using accepted socioeconomic methodologies. Although most criteria related to environmental justice may not be essential to a reasoned choice among alternatives, health impacts may be essential. Nevertheless, long-term health studies are pending and may not be available for use for several years or longer. What credible information is available was applied using accepted methodologies in the health analysis below. The BOEM will continue to seek additional information as it becomes available and bases the previous analysis on the best information currently available.

Summary and Conclusion

The cumulative impacts of a CPA proposed action would occur within the context of other impact-producing factors on environmental justice, including (1) proposed actions and the OCS Program,

(2) State oil and gas activity, (3) existing infrastructure associated with petrochemical processing including refineries and polyvinyl plants, (4) existing waste facilities including landfill, (5) coastal erosion/subsidence, (6) hurricanes, and (7) the lingering impacts of the DWH event.

Because of the presence of an extensive and widespread support system for the OCS and associated labor force, the effects of the cumulative case are expected to be widely distributed and, except in Louisiana, little felt. In general, the cumulative effects of the OCS Program are expected to be economic and to have a limited but positive effect on low-income and minority populations. In Louisiana, these positive economic effects are expected to be greater. In general, who would be hired and where new infrastructure might be located is impossible to predict. Given the existing distribution of the OCS-related industry and the limited concentrations of minority and low-income peoples, the cumulative OCS Program would not have a disproportionate effect on these populations. Lafourche Parish would experience the most concentrated effects of cumulative impacts. These groups are not expected to be differentially affected because the parish is not heavily low-income or minority and the effects of road traffic and port expansion would not occur in areas of low-income or minority concentration. To summarize, a CPA proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people, and in the GOM coastal area, the contribution of a CPA proposed action and the OCS Program to the cumulative effects of all activities and trends affecting environmental justice issues over the next 40 years is expected to be negligible to minor. The cumulative effects would be concentrated in coastal areas, and particularly Louisiana. Most OCS Program effects are expected to be in the areas of job creation and the stimulation of the economy, and they are expected to make a positive contribution to economic justice. The contribution of the cumulative OCS Program to the cumulative impacts of all factors affecting environmental justice is expected to be minor; therefore, the incremental contribution of a CPA proposed action to the cumulative impacts would also be minor. State offshore leasing programs in Alabama and Louisiana have similar, although more limited effects, due to their smaller scale. Cumulative effects from onshore infrastructure, including waste facilities, is also expected to be minor because existing infrastructure is regulated, because little new infrastructure is expected to result in the cumulative case, and because any new infrastructure would be subject to relevant permitting requirements. Coastal landloss/subsidence, hurricanes, and global warming all raise environmental justice issues, as do the potential long-term effects of the DWH event. The cumulative consequences to environmental justice cannot be determined at this time. Nevertheless, a single OCS lease sale added to existing State and Federal leasing programs and the associated onshore infrastructure would make only minor contributions to these cumulative effects.

4.2.1.24. Species Considered due to U.S. Fish and Wildlife Concerns

Background/Introduction

The FWS has explicitly communicated interest in specific species within State boundaries along the Gulf Coast (**Table 4-82**). The species within Louisiana, Mississippi, Alabama, and Florida have been designated as endangered, threatened, candidate, listed with critical habitat, proposed nonessential experimental population, or distinct vertebrate population. From **Table 4-82**, the following species and the potential impacts, if applicable, have been discussed elsewhere within this EIS: West Indian manatee (**Chapter 4.2.1.12**); green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles (**Chapter 4.2.1.13**); Alabama, Perdido Key, and Choctawhatchee beach mice (**Chapter 4.2.1.15**); red-cockaded woodpecker, Mississippi sandhill crane, piping plover, whooping crane, least tern, and wood stork (**Chapter 4.2.1.16**); and Gulf sturgeon (**Chapter 4.2.1.17**). The BOEM has only focused on species within coastal counties because those are the species that could be potentially impacted by oil and gas development activities, including a potential OCS spill.

One mammal species listed in **Table 4-82** (Louisiana black bear) is not known to inhabit the coastal areas of Louisiana and Mississippi and is therefore not discussed elsewhere in this EIS. The Louisiana black bear is known to, or is believed to, occur in Iberia and St. Mary Parishes in Louisiana and in Hancock, Harrison, and Jackson Counties in Mississippi (USDOI, FWS, 2009f). On March 10, 2009 (74 FR 10350-10409), critical habitat was designated in the lower Atchafalaya Basin (133,636 ac; 54,081 ha), with the southernmost boundary approximately 15 mi (24 km) from the Gulf of Mexico in St. Mary Parish, Louisiana. In addition to bottomland hardwood forests, bears within this unit of critical habitat also use upland hardwood habitats associated with four salt domes (Avery, Cote Blanche, Weeks

Islands, and Belle Isle) and coastal marshes adjacent to those forests. The coastal habitat is not a preferred habitat for Louisiana black bears. The greatest threats to this species are the loss of habitat and fragmentation caused by urban and agricultural development.

The two plant species within **Table 4-82** (Louisiana quillwort and telephus spurge) are not known to inhabit the coastal areas of Mississippi and Florida, respectively, and are therefore not discussed elsewhere in this EIS. The Louisiana quillwort is known to, or is believed to, occur in Hancock, Harrison, and Jackson Counties in Mississippi. Louisiana quillwort occurs in the Pleistocene High Terraces in southern Mississippi. It appears to be restricted to sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland/bayhead forests of pine flatwoods and upland longleaf pine, which is approximately 25 mi (40 km) inland from the Gulf of Mexico (USDOI, FWS, 1996). The telephus spurge is known to, or is believed to, occur in Bay, Gulf, and Franklin Counties in Florida. The telephus spurge is endemic to the Florida Panhandle, and the present remaining patches are separated by clear cuts, pine plantations, or residential/commercial development (USDOI, FWS, 2008c). These plants do well on sandy, acidic soil, with no litter, and low organic and moisture content; are abundant at newly disturbed sites; and are found along major U.S. Highway 98, which is approximately 2 mi (3 km) from the Gulf of Mexico in these counties. The greatest threats to these species are the loss of and/or modification to suitable habitat caused by urban and agricultural development.

The six reptile species within **Table 4-82** (gopher tortoise, Alabama red-belly turtle, ringed map turtle, black pine snake, yellow-blotched map turtle, and eastern indigo snake) are not known to inhabit the coastal areas of Louisiana, Mississippi, Alabama, and Florida, and are therefore not discussed elsewhere in this EIS. The gopher tortoise is known to, or is believed to, occur in southeastern Louisiana; Hancock, Harrison, and Jackson Counties in Mississippi; and Mobile County in Alabama. On July 27, 2011, the FWS announced a 12-month finding on a petition to list the gopher tortoise (*Gopherus polyphemus*) in the eastern portion of its range (east of the Mobile and Tombigbee Rivers) as a threatened species and to designate critical habitat under the Endangered Species Act of 1973, as amended. In this finding, the status of the gopher tortoise in the western portion of its range (west of the Mobile and Tombigbee Rivers) will be evaluated to determine its accuracy (76 FR 45130-45162). This species is found on droughty, deep sand ridges, which originally supported longleaf pine and patches of scrub oak in upland habitats (USDOI, FWS, 1990c). Gopher tortoises may also be found in rural habitats such as fence rows, pastures, and field edges and power lines, which are ideal for burrows. The Alabama red-belly turtle is known to, or is believed to, occur in Harrison and Jackson Counties in Mississippi and in Mobile and Baldwin Counties in Alabama. The Alabama red-belly turtle inhabits broad, vegetated expanses of shallow freshwater (1-2 m [3.3-6.6 ft] in depth) in the backwater areas of bays and in and along river channels (USDOI, FWS, 1989). A known major nesting site is the dredged material disposal area on Gravine Island, located north of the Highway 90 Causeway in the Mobile-Tensaw Delta, which is about 8 mi (13 km) north of Interstate 10. The ringed map turtle is known to, or is believed to, occur in southeastern Louisiana and in Hancock County in Mississippi. The ringed map turtle is restricted to the Pearl River and its major tributaries. It is not found in the tidally influenced section of the lower West Pearl River (USDOI, FWS, 2010g). The black pine snake is known to, or is believed to, occur in Harrison and Jackson Counties in Mississippi and in Mobile County in Alabama. The black pine snake is endemic to the upland longleaf pine forests consisting of sandy, well-drained soils with an overstory of longleaf pine, a fire suppressed mid-story, and dense herbaceous ground cover. The majority of black pine snake populations are concentrated in the De Soto National Forest, which is less than 10 mi (16 km) north of Interstate 10 (USDOI, FWS, 2010h). The yellow-blotched map turtle is known to, or is believed to, occur in Jackson County in Mississippi. The yellow-blotched map turtle is a species of rivers and large creeks and prefers habitat with moderate currents, abundant basking sites, and sand bars. It is present in the Pascagoula River from its point of origin near Merrill in George County, south to where the river forks into the East and West Pascagoula Channels near Vancleave in Jackson County (USDOI, FWS, 1993). Within the East and West Pascagoula Channels, the yellow-blotched map turtle has been observed to the I-10 Bridge, which is about 8 mi (13 km) from the Gulf of Mexico. The eastern indigo snake is known to, or is believed to, occur in Mobile and Baldwin Counties in Alabama and in all eastern coastal counties within Florida. The eastern indigo snake can be found in all terrestrial habitats that have not suffered high-density urban development. It is also closely associated with gopher tortoise burrows, which are not close to the Gulf of Mexico (USDOI, USFWS, 2008a). The greatest threats to these species are the loss of and/or modification to suitable habitat caused by urban and agricultural development. .

The two amphibian species within **Table 4-82** (Mississippi gopher frog and flatwoods salamander) are not known to inhabit the coastal areas of Mississippi and Alabama/Florida, respectively, and are not discussed elsewhere in this EIS. The Mississippi gopher frog is known to, or is believed to, occur in Harrison and Jackson Counties in Mississippi. The primary breeding site for the Mississippi gopher frog is in the De Soto National Forest in Mississippi. Based on current monitoring efforts, it is estimated that less than 100 adult Mississippi gopher frogs remain (USDOI, FWS, 2009g). On June 3, 2010 (75 FR 31387-31411), critical habitat was proposed for the Mississippi gopher frog, with the closest area approximately 7 mi (11 km) from the Gulf of Mexico. The frosted flatwoods salamander (*Ambystoma cingulatum*) is known to, or is believed to, occur in Franklin, Wakulla, and Jefferson Counties in Florida. The reticulated flatwoods salamander (*Ambystoma bishopi*) is known to, or is believed to, occur in Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf Counties in Florida. On February 10, 2009 (74 FR 6700-6774), critical habitat was finalized for both species of flatwoods salamanders, with the closest area approximately 3 mi (5 km) from the Gulf of Mexico. These salamanders breed in ponds and live primarily underground in upland habitats of longleaf pine flatwoods during the nonbreeding season. The greatest threats to these species are the loss of and/or modification to suitable habitat. The loss of habitat includes logging, urban and agricultural sprawl, invasive plants, and drought.

The two amphibian species within **Table 4-82** (Mississippi gopher frog and flatwoods salamander) are not known to inhabit the coastal areas of Mississippi and Alabama/Florida, respectively, and are therefore not discussed elsewhere in this EIS. The pallid sturgeon is known to, or is believed to, occur in the Mississippi River currently and in the Atchafalaya River historically (USDOI, FWS, 2007b). Present-day documentation of pallid sturgeon in the Atchafalaya River has been primarily limited to the area of the Old River Control Structure, where the fish are entrained and passed from the Mississippi River to the Atchafalaya River. Pallid sturgeon are rarely found in the coastal areas such as the Atchafalaya Bay (Hartfield, official communication, 2011) and have not been documented in this area in the recent past. This species is a bottom oriented, large rivers obligate, and has only been documented in the Mississippi River as far south as the Highway 90 bridge (Huey P. Long) near Avondale, Louisiana, approximately 105 river miles (169 river kilometers) from the Gulf of Mexico (Slack, official communication, 2011b). The pearl darter is known to, or is believed to, occur in Jackson County, Mississippi, and currently inhabits only navigable waters of the Pascagoula River drainage from the Leaf and Chickasawhay Rivers, downstream to approximately River Mile 30 (USDOI, FWS, 2010i). The greatest threats to these species are the loss of habitat caused by urban and agricultural development.

The one bivalve species within **Table 4-82** (inflated heelsplitter) are not known to inhabit the coastal areas of Mississippi and Alabama and therefore are not discussed elsewhere in this EIS. The inflated heelsplitter (or Alabama heelsplitter) is known to, or is believed to, occur in Hancock County in Mississippi and in Baldwin County in Alabama (USDOI, FWS, 1992). The Alabama heelsplitter, a freshwater mussel, has a presently known distribution limited to the Amite River in Louisiana and to five sites in the Tombigbee and Black Warrior Rivers in Alabama (USDOI, FWS, 2011e). The greatest threat to this species is the loss of suitable habitat caused by urban and agricultural development.

Proposed Action Analysis

Adverse impacts due to routine activities resulting from a CPA proposed action are possible but unlikely. Because of the greatly improved handling of waste and trash by industry and because of the annual awareness training required by the marine debris mitigations, the plastics in the ocean are decreasing and the devastating effects on offshore and coastal marine life are minimizing. The routine activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any above-mentioned species or population in the GOM due to the distance of most activities; the heavy regulation of infrastructure and pipelines; and permitting and siting requirements.

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters has a 3-5 percent and 9-16 percent probability of impacting Texas State offshore waters, based on a CPA proposed action (**Figure 3-8**). State offshore waters in Louisiana, Mississippi, Alabama, and Florida are also estimated for the CPA in **Figure 3-8**. Additionally, the Florida Panhandle offshore waters had a 1-2 percent 30-day probability of a spill risk from a CPA proposed action (**Figure 3-8**).

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring and contacting near coastal GOM counties/parishes within a CPA proposed action would impact a total of 15 counties/parishes with a >0.5 percent probability (**Figure 3-9**). The Chandeleur Islands have a 1-2 percent and 2-3 percent (10- and 30-day probabilities) risk of impact from an OCS spill occurrence resulting from a CPA proposed action (**Figure 3-8**). The Tortugas Ecological Reserve and Dry Tortugas have a <0.5 percent and <0.5 percent (10- and 30-day probabilities) risk of impact from an OCS spill occurrence resulting from either a CPA or WPA proposed action. The Florida Keys National Marine Sanctuary has a <0.5 percent and <0.5-1 percent (10- and 30-day probabilities) risk of impact from an OCS spill occurrence resulting from a CPA proposed action (**Figure 3-8)**.

In general terms, coastal waters of the planning area may be contacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 and <1,000 bbl); and a single, large (≥1,000 bbl) spill as a result of a WPA or CPA proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters, compared with platforms and tankers (**Table 3-8**). Spill estimates for the CPA over a 40-year time period indicate 234-404 spills with median spill size of <0.024 bbl of oil might be introduced in offshore waters from small spills (≤1 bbl) (**Table 3-12**). An estimated maximum number of 17 spills with a median spill size between 3 and 130 bbl of oil could be spilled in quantities of a >1 to <1,000 bbl spill event. A single, large spill (≥1,000 bbl) is estimated to introduce a median spill size of 2,200 bbl of oil with <1 spill. The actual number of spills that may occur in the future could vary from the estimated number. A spill size group for ≥10,000 bbl was not included in **Table 3-12** because the catastrophic DWH oil spill (with approximately 4.9 MMbbl released from the well) was the only spill in this size range during 1996-2010, and thus, limited conclusions can be made from a single data point (**Table 3-12**). The total volume for offshore spills ≥1,000 bbl between 2011 and 2050 as a result of the CPA proposed actions is estimated at 0.460-0.894 Bbbl of oil (**Table 3-12**).

At this time, there is no known record of a hurricane crossing the path of a large oil spill; the impacts of such have yet to be determined. The experience from Hurricanes Katrina and Rita in 2005 was that the oil released during the storms widely dispersed as far as the surge reached (USDOC, NOAA, 2010d). Due to their reliance on terrestrial habitats to carry out their life-history functions at a considerable distance from the GOM, the activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any of the above-mentioned species or populations in Louisiana, Mississippi, Alabama, and Florida.

As data continue to be gathered and impact assessments completed, a better characterization of the full scope of impacts to populations in the GOM from the DWH event will be available. Relevant data on the status of populations after the DWH may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches. Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this EIS. As of May 2012, there are 4,377 active leases in the CPA with ongoing (or the potential for) exploration, drilling, and production activities. In addition, non-OCS energy-related activities will continue to occur in the CPA irrespective of a CPA proposed action (i.e., habitat loss and competition). The potential for effects from changes to the affected environment (post-DWH), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this EIS.

Summary and Conclusion

Because of the mitigations that may be implemented (**Chapter 2.4.1.3**), routine activities (e.g., operational discharges, noise, and marine debris) related to a CPA proposed action are not expected to have long-term adverse effects on the size and productivity of any of these species or populations in the GOM. Lethal effects could occur from ingestion of accidentally released plastic materials from OCS vessels and facilities. However, there have been no reports to date on such incidences. The BOEM employs several measures (e.g., marine debris mitigations) to reduce the potential impacts to any animal from routine activities associated with a proposed action. Accidental blowouts, oil spills, and spill-response activities resulting from a CPA proposed action have the potential to impact small to large areas in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors (including tropical storms). The incremental contribution of a CPA proposed action would not be likely to result in a significant incremental impact on the above-mentioned species within the CPA in **Table 4-82**; in comparison, non-OCS related activities, such as habitat loss and competition, have historically proved to be of greater threat to the above mentioned species in **Table 4-82**.

In conclusion, within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting the above-mentioned species populations in **Table 4-82**; therefore, a CPA proposed action would be expected to have little or no effect on the above-mentioned species in **Table 4-82**. The conclusions for the following species can be found in their respective chapters of this EIS: West Indian manatee (**Chapter 4.2.1.12**); green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles (**Chapter 4.2.1.13**); Alabama, Perdido Key, and Choctawhatchee beach mice (**Chapter 4.2.1.15**); red-cockaded woodpecker, Mississippi sandhill crane, piping plover, whooping crane, least tern, and wood stork (**Chapter 4.2.1.16**); and Gulf sturgeon (**Chapter 4.2.1.17**).

4.2.2. Alternative B—The Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (the proposed action) by not offering blocks that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.4.1.3.2**; **Figure 2-1**). All of the assumptions (including the seven other potential mitigating measures) and estimates are the same as for the proposed actions (Alternative A). A description of Alternative A is presented in **Chapter 2.4.1.1**.

Effects of the Alternative

The following analyses are based on the scenario for a CPA proposed action (Alternative A). The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. These are estimates only and not predictions of what would happen as a result of holding a proposed lease sale. A detailed discussion of the scenario and related impact-producing factors is presented in **Chapter 3.1**.

The analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts under Alternative B are expected to be the same as a CPA proposed action in the CPA (**Chapter 4.2**) for the following resources:

— Air Quality
— Water Quality
— Coastal Barrier Beaches and Associated Dunes
— Wetlands
— Seagrass Communities
— Live Bottoms (Pinnacle Trend and Low Relief)
— *Sargassum* Communities
— Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities
— Soft-Bottom Benthic Communities
— Marine Mammals
— Sea Turtles
— Diamondback Terrapins
— Alabama, Choctawhatchee, St. Andrew and Perdido Key Beach Mice
— Coastal and Marine Birds
— Gulf Sturgeon
— Fish Resources and Essential Fish Habitat
— Commercial Fishing
— Recreational Fishing
— Recreational Resources
— Archaeological Resources
— Human Resources and Land Use

The impacts to some Gulf of Mexico resources under Alternative B would be different from the impacts expected under a CPA proposed action. These impacts are described below.

Impacts on Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for a CPA proposed action. The potential impact-producing factors to the topographic features of the CPA are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors and the appropriate mitigating measures is presented in **Chapter 2.4.1.3.1.**

Of the 16 topographic features of the CPA, 15 are located within water depths less than 200 m (656 ft). Geyer Bank is located in water depths of 190-210 m (623-689 ft). These features occupy a very small portion of the entire area. Of the potential impact-producing factors that may affect the topographic features, anchoring, structure emplacement, and structure removal would be eliminated by the adoption of this alternative. Effluent discharge and blowouts would not be a threat to the topographic features because blocks near enough to the banks for these events to have an impact on the biota of the banks would have been excluded from leasing under this alternative. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill. The potential impacts from oil spills are summarized below and are discussed further in **Chapter 3.2.1**.

A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. A subsurface spill is expected to rise to the surface, and any oil remaining at depth would be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Deepwater subsurface spills may travel along the sea bottom or in the water column for some distance before rising to the surface. The fact that the topographic features are widely dispersed in the CPA, combined with the random nature of spill events, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. **Chapter 4.2.1.7** discusses the risk of spills interacting with topographic features in more detail. The currents that move around the banks would likely steer any spilled oil around the banks rather than directly upon them, lessening impact severity. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (CSA, 1992b and 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill contacted a coral-covered area, the areal extent of coral mortality would be limited, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature and diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Cumulative Impacts

With the exception of the topographic features, the cumulative impacts of Alternative B on the environmental and socioeconomic resources of the CPA would be identical to Alternative A. The incremental contribution of a CPA proposed action to the cumulative impacts on topographic features is expected to be slight, and negative impacts should be restricted by the implementation of the Topographic Features Stipulation and site-specific mitigations, the depths of the features, and water currents in the topographic feature area.

Summary and Conclusion

Alternative B, if adopted, would prevent any oil and gas activity whatsoever in the blocks containing topographic features; thus, it would eliminate any potential direct impacts to the biota of those blocks from oil and gas activities within the blocks. In the unlikely event that oil from a subsurface spill contacts the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Some lethal effects would probably occur upon oil contact to coral colonies.

Environmental impacts of Alternative B would be almost indistinguishable from Alternative A with the Topographic Features Stipulation in place. There would be an economic impact to the extent that economic returns from the excluded lease blocks would not be realized.

4.2.3. Alternative C—No Action

Description of the Alternative

Alternative C is equivalent to cancellation of a lease sale scheduled for a specific period in the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017*. By canceling a proposed lease sale, the opportunity is postponed for development of the estimated reserves of oil and gas, some of which may be ultimately foregone. Any potential environmental and socioeconomic impacts resulting from a proposed lease sale would be postponed or not occur.

Effects of the Alternative

This Agency recently published a report that examined previous exploration and development activity scenarios (USDOI, MMS, 2007e). The Agency compared forecasted activity with the actual activity from 14 WPA and 14 CPA lease sales.

The report shows that many lease sales contribute to the present level of OCS activity, and any single lease sale accounts for only a small percentage of the total OCS activities. In 2006, leases from 92 different sales contributed to Gulf of Mexico production, while an average CPA lease sales contributed to 2 percent of oil production and 2 percent of gas production in the CPA. In 2006, leases from 15 different sales contributed to the installation of production structures in the Gulf of Mexico, while an average CPA lease sale, for example, contributed to 6 percent of the installation of production structures in the CPA. In 2006, leases from 70 different sales contributed to wells drilled in the Gulf of Mexico, while an average CPA lease sale contributed to 4 percent of wells drilled in the CPA.

As in the past, a proposed CPA lease sale would contribute to maintaining the present level of OCS activity in the Gulf of Mexico. Exploration and development activity, including service-vessel trips, helicopter trips, and construction, that would result from a proposed lease sale would replace activity resulting from active leases that have reached, or are near the end of, their economic life.

Environmental Impacts

If a proposed lease sale would be canceled, the resulting development of oil and gas would most likely be postponed to a future sale; therefore, the overall level of OCS activity in the CPA would only be reduced by a small percentage, if any. Therefore, the cancellation of a lease sale would not significantly change the environmental impacts of overall OCS activity.

Although environmental impacts may be reduced or postponed by cancelling a lease sale, the economic impacts of cancelling a scheduled lease sale should be given consideration. **Chapter 4.2.1.23.3.2** discusses the potential economic impacts of a CPA proposed action. In the event that a lease sale is cancelled or postponed, there may be impacts to employment along the Gulf Coast, but these are not expected to be significant (e.g., less than 1% of total employment) or long term given the existing OCS infrastructure.

Federal, State, and local governments would also have to forgo the revenue that would have been received from a lease sale. There could be minor impacts on global energy prices from cancelling a proposed lease sale, along with minor changes in energy consumption patterns that would result from these price changes.

Other factors may minimize or exacerbate the economic impacts of cancelling a proposed lease sale. For example, the longer term economic impacts of cancelling a lease sale could be minimized if they were offset by a larger lease sale at a later date. The economic impacts may be exacerbated if additional lease sales are cancelled. The OCS industry is dependent on high capital investment costs and there may be long lags between a lease sale and the majority of production activities. Therefore, firms' investment and spending decisions are dependent on their confidence that the OCS Program will be maintained in the future. In addition, while firms in the OCS industry are generally likely to be able to weather the cancellation of a single lease sale, the cancellation of multiple lease sales could lead to broader damage to firms and workers in the industry or decisions to operate in areas other than the Gulf. These economic impacts would be particularly damaging to the coastal counties in Texas and Louisiana for which the OCS industry as a whole is an important component of their economies.

From a Programmatic perspective, cancellation of a Five-Year Program of lease sales in the Gulf of Mexico would have much greater effects in terms of economic impacts, energy strategy, and environmental impacts. For a more detailed discussion of the effects of the cancellation of a Five-Year Program of lease sales in the Gulf of Mexico, see **Appendix G.1**.

4.3. Unavoidable Adverse Impacts of the Proposed Actions

Unavoidable adverse impacts associated with a WPA or CPA proposed action are expected to be primarily short term and localized in nature and are summarized below. Adverse impacts from catastrophic events could be of longer duration and extend beyond the local area. All OCS activities involve temporary and exclusive use of relatively small areas of the OCS over the lifetimes of specific projects. Lifetimes for these activities can be days, as in the case of seismic surveys; or decades, as in the case of a production structure or platform. No activities in the OCS Program involve the permanent or temporary use or "taking" of large areas of OCS on a semicontinuous basis. Cumulatively, however, a multitude of individual projects results in a major use of OCS space.

Sensitive Coastal Habitats: If an oil spill contacts beaches or barrier islands, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced, and a beach could experience several years of tarballs washing ashore over time, causing an aesthetic impact. Sand borrowing on the OCS for coastal restorations involves the taking of a quantity of sand from the OCS and depositing it onshore, essentially moving small products of the deltaic system to another location. If sand is left where it is, it would eventually be lost to the deltaic system by redeposition or burial by younger sediments; if transported onshore, it would be lost to burial and submergence caused by subsidence and sea-level rise.

If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In more heavily oiled areas, wetland vegetation could experience suppressed productivity for several years; in more lightly oiled areas, wetland vegetation could experience die-back for one season. Epibionts on wetland vegetation and grasses in the tidal zone could be killed, and the productivity of tidal marshes for the vertebrates and invertebrates that use them to spawn and develop could be impaired. Much of the wetland vegetation would recover over time, but some wetland areas could be converted to open water. Some unavoidable impacts could occur during pipeline and other related coastal construction, but regulations are in place to avoid and minimize these impacts to the maximum extent practicable. Unavoidable impacts resulting from dredging, wake erosion, and other secondary impacts related to channel use and maintenance would occur as a result of a WPA or CPA proposed action.

Sensitive Coastal and Offshore Biological Habitats: Unavoidable adverse impacts would take place if an oil spill occurred and contacted sensitive coastal and offshore biological habitats, such as *Sargassum* at the surface; fish, turtles, and marine mammals in the water column; or benthic habitats on the bottom. There could be some adverse impacts on organisms contacted by oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals that, at this time, are not completely understood, particularly in subsurface environments.

Water Quality: Routine offshore operations would cause some unavoidable adverse impacts to varying degrees on the quality of the surrounding water. Drilling, construction, overboard discharges of drilling mud and cuttings, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. This, however, would only affect water in the immediate vicinity of the construction activity or in the vicinity of offshore structures, rigs, and platforms. The discharge of treated sewage from manned rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and biochemical oxygen demand in a small area near the discharge point for a short period of time. Accidental spills from platforms and the discharge of produced waters could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms. Spilled oil from a tanker collision would affect the water surface in combination with dispersant chemicals used during spill response. A subsurface blowout would subject the surface, water column, and near-bottom environment to spilled oil and gas released from solution, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals.

Unavoidable impacts to onshore water quality would occur as a result of chronic point- and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of lease sale activities. Vessel traffic contributes to the degradation of water quality by chronic low-quantity oil leakage, treated sanitary and domestic waste, bilge water, and contaminants known to exist in ship paints. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to point-source discharges from support facilities such as refineries and marine terminals.

Air Quality: Unavoidable short-term impacts on air quality could occur after large oil spills and blowouts because of evaporation and volatilization of the lighter components of crude oil, combustion from surface burning, and aerial spraying of dispersant chemicals. Mitigation of long-term effects from offshore engine combustion during routine operations would be accomplished through existing regulations and development of new control emission technology. Short-term effects from spill events are uncontrollable and are likely to be aggravated or mitigated by the time of year the spills take place.

Threatened and Endangered Species: Because the proposed WPA or CPA lease sale does not in and of themselves make any irreversible or irretrievable commitment of resources that would foreclose the development or implementation of any reasonable and prudent measures to comply with the Endangered Species Act, BOEM may proceed with publication of the EIS and finalize a decision among these alternatives even if consultation is not complete, consistent with Section 7(d) of the ESA. Irreversible loss of individuals that are ESA-listed species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

Nonendangered and Nonthreatened Marine Mammals: Unavoidable adverse impacts to nonendangered and nonthreatened marine mammals would be those that also affect endangered and threatened marine mammal species. Routine operation impacts (such as seismic surveys, water quality and habitat degradation, helicopter disturbance, vessel collision, and discarded trash and debris) would be negligible or minor to a population, but they could be lethal to individuals as in the case of a vessel collision. A large oil spill would temporarily degrade habitat if spilled oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals contact free-ranging pods or spawning grounds.

Coastal and Marine Birds: Unavoidable adverse impacts from routine operations on coastal birds could result from helicopter and OCS service-vessel traffic, facility lighting, and floating trash and debris. Marine birds could be affected by noise, platform lighting, aircraft disturbances, and trash and debris associated with offshore activities. Cross-Gulf migrating species could be affected by lighted platforms, helicopter and vessel traffic, and floating trash and debris. If a large oil spill occurs and contacts coastal or marine bird habitats, some birds could experience lethal and sublethal impacts from oiling, and birds feeding or resting in the water could be oiled and die. Coastal birds coming into contact with oil may migrate more deeply into marsh habitats, out of reach from spill responders seeking to count them or collect them for rehabilitation. Oil spills and oil-spill cleanup activities could also affect the food species for coastal, marine, and migratory bird species.

Fish Resources and Commercial Fisheries: Unavoidable adverse impacts from routine operations are loss of open ocean or bottom areas desired for fishing by the presence or construction of OCS facilities and pipelines. Loss of gear could occur from bottom obstructions around platforms and subsea production systems. Routine discharges from vessels and platforms are minor given the available area for fish habitat. If a large oil spill occurs, the oil, dispersant chemicals, or emulsions of oil droplets and dispersant chemicals could temporarily displace mobile fish species on a population or local scale. It is unlikely that fishermen would want, or be permitted, to harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable.

Recreational Beaches: Unavoidable adverse impacts from routine operations may result in the accidental loss overboard of some floatable debris that may eventually come ashore on frequented recreational beaches. A large oil spill could make landfall on recreational beaches, leading to local or regional economic losses and stigma effects, causing potential users to avoid the area after acute impacts have been removed. Some recreational beaches become temporarily soiled by weathered crude oil, and tarballs may come ashore long after stranded oil has been cleaned from shoreline areas.

Economic Activity: Net economic, political, and social benefits accrue from the production of hydrocarbon resources. Once these benefits become routine, unavoidable adverse impacts from routine operations follow trends in supply and demand based on the commodity prices for oil, gas, and refined hydrocarbon products. Declines in oil and gas prices can lead to activity ramp downs by operators until prices rise. A large oil spill would cause temporary increases in economic activity associated with spill-response activity. An increase in economic activity from the response to a large spill could be offset by temporary work stoppages that are associated with spill-cause investigations and would involve a transfer or displacement of demand to different skill sets. Routine operations affected by new regulations that are incremental would not have much effect on the baseline of economic activity; however, temporary work stoppages or the introduction of several new requirements at one time that are costly to implement could cause a drop off of activity as operators adjust to new expectations or use the opportunity to move resources to other basins where they have interests.

Archaeological Resources: Unavoidable adverse impacts from routine operations could lead to the loss of unique or significant archaeological information if unrecognized at the time an area is disturbed. Required archaeological surveys significantly reduce the potential for this loss by identifying potential archaeological sites prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. A large oil spill could make landfall on or near protected archaeological landmarks to cause temporary aesthetic or cosmetic impacts until the oil is cleaned or degrades.

4.4. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible or irretrievable commitment of resources refers to impacts or losses to resources that cannot be reversed or recovered. Examples are when a species becomes extinct or when wetlands are permanently converted to open water. In either case, the loss is permanent.

Wetlands: An irreversible or irretrievable loss of wetlands and associated biological resources could occur if wetlands are permanently lost because of impacts caused by dredging and construction activities that displace existing wetlands or from oil spills severe enough to cause permanent die-back of vegetation and conversion to open water. Construction and emplacement of onshore pipelines in coastal wetlands displace coastal wetlands in disturbed areas that are then subject to indirect impacts like saltwater intrusion or erosion of the marsh soils along navigation channels and canals. Ongoing natural and anthropogenic processes in the coastal zone, only one of which is OCS-related activity, can result in direct and indirect loss of wetlands. Natural losses as a consequence of the coastal area becoming hydrologically isolated from the Mississippi River that built it, sea-level rise, and subsidence of the delta platform in absence of new sediment added to the delta plain appear to be much more dominant processes impacting coastal wetlands.

Sensitive Nearshore and Offshore Biological Resources: An irreversible loss or degradation of ecological habitat caused by cumulative activity tends to be incremental over the short term. Irretrievable loss may not occur unless or until a critical threshold is reached. It can be difficult or impossible to identify when that threshold is, or would be, reached. Oil spills and chronic low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly a reduction or even elimination of a few small or isolated populations. The proposed biological stipulations, however, are expected to eliminate most of these risks.

Threatened and Endangered Species: Irreversible loss of individuals that are protected species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

Fish Resources and Commercial Fisheries: Irreversible loss of fish and coral resources, including commercial and recreational species, are caused by structural removal using explosives. Fish in proximity to an underwater explosion can be killed. Without the structure to serve as habitat area, sessile, attached invertebrates and the fish that live among them is absent. Removing structures eliminates these special and local habitats and the organisms living there, including such valuable species as red snapper. Continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures.

Recreational Beaches: Impacts on recreational beaches from a large oil spill may at the time seem irreversible, but the impacts are generally temporary. Beaches fouled by a large oil spill would be temporarily unavailable to the people who would otherwise frequent them, but only during the period between landfall and cleanup of the oil, followed by an indefinite lag period during which stigma effects recede from public consciousness.

Archaeological Resources: Irreversible loss of a prehistoric or historic archaeological resource can occur if bottom-disturbing activity takes place without the required survey to demonstrate its absence before work proceeds. A resource can be completely destroyed, severely damaged, or the scientific context badly impaired by well drilling, subsea completions, and platform and pipeline installation, or sand borrowing.

Oil and Gas Development: Leasing and subsequent development and extraction of hydrocarbons as a result of a WPA or CPA proposed action represents an irreversible and irretrievable commitment by the removal and consumption of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of a WPA or CPA proposed action is presented in **Table 3-1**.

Loss of Human and Animal Life: The OCS oil and gas exploration, development, production, and transportation are carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public and work place safety and environmental protection. Nevertheless, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (i.e., unavoidable accidents, accidents caused by human negligence or misinterpretation, human error, willful noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal, can kill sea life in proximity to explosive charges or by removal of the structure that served as the framework for invertebrates living on it and the fish that lived with it.

4.5. RELATIONSHIP BETWEEN THE SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term effects on various components of the environment in the vicinity of a WPA or CPA proposed action are related to long-term effects and the maintenance and enhancement of long-term productivity.

Short-Term Use

Short-term refers to the total duration of oil and gas exploration and production activities. Extraction and consumption of offshore oil and natural gas is a short-term benefit. Discovering and producing domestic oil and gas now delays the increase in the Nation's dependency on foreign imports. Depleting a nonrenewable resource now removes these domestic resources from being available for future use. The production of offshore oil and natural gas from a WPA or CPA proposed action would provide short-term energy, and as it delays the increase in the Nation's dependency on foreign imports, it can also allow additional time for ramp-up and development of long-term renewable energy sources or substitutes for nonrenewable oil and gas. Economic, political, and social benefits would accrue from the availability of these natural resources.

The principle short-term use of the leased areas in the GOM would be for the production of 0.116-0.200 BBO and 0.538-0.938 Tcf of gas from a typical WPA proposed action and 0.460-0.894 BBO and 1.939-3.903 Tcf of gas from a typical CPA proposed action. The cumulative impacts scenario in this EIS extends approximately from 2012 to 2051. The 40-year time period is used because it is the approximate longest life span of activities conducted on an individual lease. The 40 years following a proposed WPA or CPA lease sale is the period of time during which the activities and impacting-factors that follow as a consequence of the proposed lease sale would be influencing the environment.

The specific impacts of a WPA or CPA proposed action vary in kind, intensity, and duration according to the activities occurring at any given time (**Chapter 3**). Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling and well workovers occur sporadically throughout the life of a proposed action but also result in short-term, localized impacts. Activities during the production life of a platform may result in chronic impacts over a longer period of time (over 25 years), potentially punctuated by more severe impacts as a result of accidental events or a spill. Platform removal is also a short-term activity with localized impacts, including removal of the habitat for encrusting invertebrates and fish living among them. Many of the effects on physical, biological, and socioeconomic resources discussed in **Chapter 4** are considered to be short term (being greatest during the construction, exploration, and early production phases). These impacts would be further reduced by the mitigating measures discussed in **Chapter 2**.

The OCS development off Texas, Louisiana, Mississippi, and Alabama has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and specialized recreational fishing equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. A WPA or CPA proposed action could increase these incidental benefits of offshore development. Offshore fishing and diving has gradually increased in the past three decades, with offshore structures and platforms becoming the focus of much of that activity. As mineral resources become depleted, platform removals would occur and may result in a decline in these activities.

The short-term exploitation of hydrocarbons for the OCS Program in the GOM may have long-term impacts on biologically sensitive coastal and offshore resources and areas if a large oil spill occurs. A spill and spill-response activity could temporarily interfere with commercial and recreational fishing, beach use, and tourism in the area where the spill makes landfall and in a wider area based on stigma effects. The proposed leasing may also result in onshore development and population increases that could cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure (**Chapters 4.2.1.23.1 and 4.2.1.23.2**).

Relationship to Long-Term Productivity

Long-term refers to an indefinite period beyond the termination of oil and gas production. Over a period of time after peak oil production has occurred in the GOM, a gradual easing of the specific impacts caused by oil and gas exploration and production would occur as the productive reservoirs in the GOM have been discovered and produced, and have become depleted. The Oil Drum (2009) showed a graphic demonstrating that peak oil production in the GOM occurred in June 2002 at 1.73 MMbbl/day. Whether or not this date is correct can only be known in hindsight and only after a period of years while production continues. At this time, however, the trend is fairly convincing (The Oil Drum, 2009). There is disagreement on what future production trends may be in the GOM after several operators, BP among them, announced discoveries over the last 5 years (Oil and Gas Journal, 2009) in the Lower Tertiary in ultra-deepwater with large projected reserves. These claims are as yet unproven and there are questions as to the difficulties that may be encountered producing these prospects because of their geologic age, burial depth and high-temperature, high pressure in-situ conditions, lateral continuity of reservoirs, and the challenges of producing from ultra-deepwater water depths.

The GOM's large marine ecosystem is considered a Class II, moderately productive ecosystem (mean phytoplankton primary production 150-300 gChlorophyll-*a*/m^2-yr [The Encyclopedia of Earth, 2008]), based on Sea-viewing Wide Field-of-view Sensor (SeaWiFS) global primary productivity estimates (USDOC, NASA, 2003). After the completion of oil and gas production, a gradual ramp-down to economic conditions without oil and gas activity would be experienced, while the marine environment is generally expected to remain at or return to its normal long-term productivity levels that in recent years has been described as stressed (The Encyclopedia of Earth, 2008). The GOM's large marine ecosystem shows signs of ecosystem stress in bays, estuaries, and coastal regions (Birkett and Rapport, 1999). There is shoreline alteration, pollutant discharge, oil and gas development, and nutrient loading. The overall condition for the U.S. section of this large marine ecosystem, according to USEPA's seven primary indicators (Jackson et al., 2000), is good dissolved oxygen, fair water quality, poor coastal wetlands, poor eutrophic condition, and poor sediment, benthos, and fish tissue (The Encyclopedia of Earth, 2008).

To help sustain the long-term productivity of the GOM ecosystem, the OCS Program provides structures to use as site-specific artificial reefs and fish-attracting devices for the benefit of commercial and recreational fishermen and to sport divers and spear fishers. Additionally, the OCS Program continues to improve the knowledge and mitigation practices used in offshore development. Approximately 10 percent of the oil and gas structures removed from the OCS are eventually used for State artificial reef programs.

CHAPTER 5

CONSULTATION AND COORDINATION

5. CONSULTATION AND COORDINATION

5.1. DEVELOPMENT OF THE PROPOSED ACTIONS

This Multisale EIS addresses 10 proposed WPA and CPA Gulf of Mexico OCS lease sales, as scheduled in the *Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017* (**Figure 1.1**). This Agency conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for the proposed lease sales and EIS. Key agencies and organizations included the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), U.S. Coast Guard (USCG), U.S. Department of Defense (DOD), U.S. Environmental Protection Agency (USEPA), State Governors' offices, and industry groups.

5.2. NOTICE OF INTENT TO PREPARE AN EIS AND CALL FOR INFORMATION AND NOMINATIONS

On February 9, 2011, the Notice of Intent to Prepare an EIS (NOI) for the proposed WPA and CPA lease sales was published in the *Federal Register*. Additional public notices were distributed via local newspapers, the U.S. Postal Service, and the Internet. A 45-day comment period was provided; it closed on March 28, 2011. Federal, State, and local governments, along with other interested parties, were invited to send written comments to the Gulf of Mexico OCS Region on the scope of the EIS. This Agency received 20 comment letters and 1,232 e-mails in response to the NOI. These comments are summarized below in **Chapter 5.3.1**.

On March 15, 2011, the Call for Information and Nominations (Call) for the proposed WPA and CPA lease sales was published in the *Federal Register*. The comment period closed on April 14, 2011. This Agency received nine comment letters in response to the Call. These comments are summarized below in **Chapter 5.3.2**.

5.3. DEVELOPMENT OF THE DRAFT MULTISALE EIS

Scoping for the Draft Multisale EIS was conducted in accordance with CEQ regulations implementing NEPA. Scoping provides those with an interest in the OCS Program an opportunity to provide comments on the proposed actions. In addition, scoping provides BOEM an opportunity to update the Gulf of Mexico OCS Region's environmental and socioeconomic information base. The scoping process officially commenced on February 9, 2011, with the publication of the NOI in the *Federal Register*. Formal scoping meetings were held in Texas, Louisiana, and Alabama. The dates, times, locations, and public attendance of the scoping meetings for the proposed WPA and CPA lease sales were as follows:

Tuesday, February 15, 2011
1:00 p.m. CST until adjournment
Houston Airport Marriott
George Bush Intercontinental
18700 John F. Kennedy Boulevard
Houston, Texas
40 registered attendees
10 speakers

Wednesday, February 16, 2011
1:00 p.m. CST until adjournment
Hilton New Orleans Airport
901 Airline Drive
Kenner, Louisiana
35 registered attendees
15 speakers

Thursday, February 17, 2011
7:00 p.m. CST until adjournment
Five Rivers—Alabama's Delta Resource Center
30945 Five Rivers Boulevard
Spanish Fort, Alabama
75 registered attendees
17 speakers

5.3.1. Summary of Scoping Comments

Comments (both written and verbal) were received in response to the NOI and three scoping meetings from Federal, State, and local governmental agencies; interest groups; industry; businesses; and the general public on the scope of the EIS, significant issues that should be addressed, alternatives that should be considered, and mitigating measures. All scoping comments received, which were appropriate for a lease sale NEPA document, were considered in the preparation of the Draft Multisale EIS. Comments received included the following:

- select the No Action alternative;
- further develop and adjust focus to alternative energy;
- move away from the Nation's dependency on oil and gas;
- no new leasing and drilling activity until the Oil Spill Commission's recommendations are adopted and implemented;
- develop comprehensive standards for baseline environmental information to evaluate the effects of offshore oil and gas operations;
- conduct an immediate, systematic, and rigorous expert review of the state of environmental knowledge in the Gulf to provide the basis for the EIS;
- work with NOAA, FWS, and the Marine Mammal Commission to develop comprehensive standards for baseline environmental information needed to evaluate the potential effects of offshore oil and gas operations on marine mammals and their environment;
- adequately determine data gaps within the information used to write the EIS;
- work with the oil and gas industry to fully fund and expand environmental studies for the Gulf of Mexico;
- provide comprehensive cumulative analysis of cumulative impacts from oil and gas in the context of all other uses of the offshore environment;
- conduct meetings after work hours and make them more accessible to the general public;
- the need for increased efficiency of oil-spill-response efforts; i.e., boom;
- protect threatened and endangered sea turtle breeding, foraging, and migration habitat for any new or renewed oil and gas drilling platforms or pipelines;
- assess the impacts to marine fish managed by State and Federal agencies, essential fish habitat, marine mammals and their habitats, sharks, birds, sea turtles and their habitat, and estuarine or coastal habitat such as coastal marshes, mangroves, and seagrasses;
- support of the expeditious and environmentally sound exploration and development of oil and gas;
- support of the new Five-Year Program and resuming leasing and drilling activity;
- expand the OCS to include the EPA and the Mid- and South Atlantic;
- increase and ensure safety while drilling;
- support of drilling except within 15 mi (24 km) of shoreline for tourist destinations;
- develop stricter safety and environment regulations;
- use the most up-to-date data as they become available;
- thoroughly assess socioeconomic impacts of reduced leasing and drilling;

- no longer dismiss the possibility of a catastrophic event and remove the underlying assumption in EIS that a catastrophic event could not happen;
- include the worst-case discharge from the oil-spill-response plans in the EIS;
- address the toxicity of dispersants on the environment;
- use foreign aid (skimmers) during recovery and cleanup;
- make response plans more transparent and include other local, State, and Federal agencies as well as local advisory committees when making decisions regarding OCS activity;
- support of tax breaks for companies working with alternative energy research and development;
- no approval of anymore offshore/deepwater drilling permits;
- concerns for the disposal of drill cuttings—support of recycling rather than disposal;
- support of obtaining additional seismic data to increase the knowledge base and increase safety when exploring deepwater and subsalt targets;
- support of exploration and drilling activity in CPA and WPA where there is a good track record and a solid knowledge base;
- support of drilling in the EPA (Florida is third largest oil consumer in this country and the sixth largest natural gas consumer in the Nation. It is important that states that are big consumers seriously look at being more a part of the national production supply.);
- development of oil and gas resources in an environmentally responsible manner;
- energy security for the United States;
- Alabama's economy is directly impacted by the future of these offshore oil and gas activities;
- continuation of the process of offshore leasing in the Gulf of Mexico is important to sustain jobs for our economy, as well as future expansions to our area; and
- encouraged the reopening of the removed blocks into the leasing process so that more opportunities at expansion and growth can occur.

5.3.2. Summary of Comments Received in Response to the Call for Information

In response to the Call, this Agency received nine comment letters: one letter from the Louisiana Department of Natural Resources; four letters from industry (American Petroleum Institute, Chevron U.S.A. Inc., ExxonMobil Exploration Company, and Statoil USA E&P Inc.); one letter from the Center for Regulatory Effectiveness; and three letters from private citizens. The letter from the Louisiana Department of Natural Resources stated that the future of Louisiana is tied to the oil and gas industry and several small businesses and those workers in Louisiana are directly affected by this industry. The American Petroleum Institute, Chevron U.S.A. Inc., ExxonMobil Exploration Company, and Statoil USA E&P Inc., and two of the private citizens' letters all supported the proposed lease sales. The American Petroleum Institute represents over 450 members involved in the oil and gas industry and fully supports holding as many lease sales as possible in the 2012-2017 timeframe. The Center for Regulatory Effectiveness' comment letter related to BOEMRE's application of the Data Quality Act Guidelines. The remaining letter, from a private citizen, dealt with concerns affecting the Arctic National Wildlife Refuge.

5.3.3. Additional Scoping Opportunities

Although the scoping process is formally initiated by the publication of the NOI, scoping efforts and other coordination meetings have proceeded and will continue to proceed throughout this NEPA process.

The Gulf of Mexico OCS Region's Information Transfer Meetings provide an opportunity for BOEM analysts to attend technical presentations related to OCS Program activities and to meet with representatives from Federal, State, and local agencies; industry; BOEM contractors; and academia. Scoping and coordination opportunities were also available during BOEM's requests for information, comments, input, and review of its other NEPA documents, including the following:

- scoping and comments on the proposed 2012-2017 OCS Oil and Gas Leasing Program's Draft Five-Year Program EIS;
- requests for comments on the Supplemental EIS for proposed WPA Lease Sale 218; and
- requests for comments on the Supplemental EIS for proposed CPA Lease Sale 216/222.

5.3.4. Cooperating Agency

According to Part 516 of the DOI Departmental Manual, BOEM must invite eligible governmental entities to participate as cooperating agencies when developing an EIS in accordance with the requirements of NEPA and the CEQ regulations. The BOEM must also consider any requests by eligible governmental entities to participate as a cooperating agency with respect to a particular EIS, and then to either accept or deny such requests.

The NOI, which was published on February 9, 2011, included an invitation to other Federal agencies and State, tribal, and local governments to consider becoming cooperating agencies in the preparation of this EIS. On December 8, 2010, BOEMRE received a request from USEPA to participate as a cooperating agency, and BOEMRE has accepted that request. In its request, USEPA stated that the NPDES General Permit for the western portion of the Gulf of Mexico OCS will expire on November 5, 2012. Reissuance of the General Permit will require the preparation of an environmental assessment under NEPA. The hypoxic zone off the coast of Louisiana and potential impacts to the Flower Garden Banks National Marine Sanctuary were two outstanding issues of concern when the General Permit was reissued in 2007. The USEPA and, then this Agency, conducted studies to establish the potential effects that discharges of produced water from oil and gas operations would have on the hypoxic zone. These studies are still necessary for the reissuance of the NPDES permit.

A Memorandum of Understanding between BOEMRE and USEPA was prepared and expresses each agency's respective roles, assignment of issues, schedules, and staff commitments. The Memorandum of Understanding was signed by USEPA on May 17, 2011, and by BOEMRE on May 27, 2011 (**Appendix E**).

5.4. DISTRIBUTION OF THE DRAFT MULTISALE EIS FOR REVIEW AND COMMENT

The BOEM sent copies of the Draft Multisale EIS to the public and private agencies and groups listed below. Local libraries along the Gulf Coast were provided copies of this document; a list of these libraries is available on the BOEM Internet website at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx.

Federal Agencies

Congress
- Congressional Budget Office
- House Resources Subcommittee on Energy and Mineral Resources
- Senate Committee on Energy and Natural Resources

Department of Commerce
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration

Department of Defense
- Corps of Engineers
- Department of the Air Force
- Department of the Army
- Department of the Navy
- Naval Mine and Anti-Submarine Warfare Command

Department of Energy
- Strategic Petroleum Reserve PMD

Department of Homeland Security
- Coast Guard

Department of State
- Bureau of Oceans and International Environmental and Scientific Affairs

Department of the Interior
- Bureau of Ocean Energy Management, Regulation and Enforcement
- Fish and Wildlife Service
- Geological Survey
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of Transportation
- Office of Pipeline Safety

Environmental Protection Agency
- Region 4
- Region 6

Marine Mammal Commission

State and Local Agencies

Alabama
- Governor’s Office
- Alabama Highway Department
- Alabama Historical Commission and State
- Alabama Public Service Commission
- Department of Conservation and Natural Resources
- Department of Environmental Management
- Historic Preservation Officer
- South Alabama Regional Planning Commission
- State Docks Department
- State Legislature Natural Resources Committee
- State Legislature Oil and Gas Committee

Florida
- Governor’s Office
- Bureau of Archaeological Research
- City of Gulf Breeze
- City of Panama City
- City of Pensacola
- Department of Community Affairs
- Department of Environmental Protection
- Department of State Archives, History and Records Management
- Escambia County
- Florida Coastal Zone Management Office
- Sarasota County Coastal Resources
- State Legislature Natural Resources and Conservation Committee
- State Legislature Natural Resources Committee
- West Florida Regional Planning Council

Louisiana
- Governor’s Office
- City of Grand Isle
- City of Morgan City
- City of New Orleans
- Department of Culture, Recreation, and Tourism
- Department of Environmental Quality
- Department of Natural Resources
- Department of Transportation and Development
- Department of Wildlife and Fisheries
- Houma-Terrebonne Chamber of Commerce
- Jefferson Parish Director
- Jefferson Parish President
- Lafourche Parish Coastal Zone Management
- Lafourche Parish Water District #1
- Louisiana Geological Survey
- South Lafourche Levee District
- St. Bernard Planning Commission
- State House of Representatives, Natural Resources Committee
- State Legislature, Natural Resources Committee

Mississippi
- Governor's Office
- City of Gulfport
- Department of Archives and History
- Department of Natural Resources
- Department of Wildlife Conservation
- Mississippi Development Authority
- State Legislature Oil, Gas, and Other Minerals Committee

Texas
- Governor's Office
- Attorney General of Texas
- City of Lake Jackson
- General Land Office
- Southeast Texas Regional Planning Commission
- State Legislature Natural Resources Committee
- State Senate Natural Resources Committee
- Texas Historical Commission
- Texas Legislation Council
- Texas Parks and Wildlife Department
- Texas Water Development Board
- Texas Sea Grant

Industry

- Air Armament Center
- Alabama Petroleum Council
- American Petroleum Institute
- Area Energy LLC
- Baker Atlas
- Bellwether Group
- B-J Services Co
- BP Amoco
- Chevron U.S.A. Inc.
- Coastal Conservation Association
- Coastal Environments, Inc.
- Continental Shelf Associates, Inc.
- Dominion Exploration & Production, Inc.
- Ecological Associates, Inc.
- Ecology and Environment
- Energy Partners, Ltd.
- EOG Resources, Inc.
- Escambia County Marine Resources
- ExxonMobil Production Company
- Florida Petroleum Council
- Florida Propane Gas Association
- Freeport-McMoRan, Inc.
- Fugro Geo Services, Inc.
- Gulf Environmental Associates
- Gulf of Mexico Newsletter
- Horizon Marine, Inc.
- Industrial Vehicles International, Inc.
- International Association of Geophysical Contractors
- J. Connor Consultants
- John Chance Land Surveys, Inc.
- Marine Safety Office
- Midstream Fuel Service
- Mote Marine Laboratory
- Murphy Exploration & Production
- Newfield Exploration Company
- *Northwest Florida Daily News*
- Petrobras America, Inc.
- PPG Industries, Inc.
- Propane Market Strategy Newsletter
- Science Applications International Corporation
- Seneca Resources Corporation
- Shell Exploration & Production Company
- Stone Energy Corporation
- Strategic Management Services-USA
- T. Baker Smith, Inc.
- Texas Geophysical Company, Inc.
- The Houston Exploration Company
- *The Washington Post*
- Triton Engineering Services Co.
- W & T Offshore, Inc.
- WEAR-TV

Special Interest Groups

- 1000 Friends of Florida
- Alabama Oil & Gas Board
- American Cetacean Society
- Audubon Louisiana Nature Center
- Bay County Audubon Society
- Citizens Assoc. of Bonita Beach
- Clean Gulf Associates
- Coastal Conservation Association
- Earthjustice
- Florida Chamber of Commerce
- Florida Institute of Oceanography
- Florida Marine Research
- Florida Natural Area Inventory
- Florida Public Interest Research Group
- Florida Sea Grant College
- Gulf Coast Environmental Defense
- Gulf County
- Gulf and South Atlantic Fisheries
- Gulf Island National Seashore
- Hernando County Planning Department
- Hunt Oil
- Izaak Walton League of America, Inc
- JOC Venture
- Louisiana State University
- Mission Enhancement Office
- Mississippi State University

Mobile Bay National Estuary Program
Natural Resources Defense Council
Nature Conservancy
Nicholls State University
Perdido Key Association
Population Connection
Portersville Revival Group
Sierra Club
South Mobile Communities Association
Southeastern Fisheries Association
The Conservancy
The Conservation Fund
The Daspit Company
The Nature Conservancy
Walton County Growth Management

Ports/Docks

Alabama
- Alabama State Port Authority
- Port of Mobile

Florida
- Panama City Port Authority

Louisiana
- Greater Baton Rouge Port Commission
- Greater Lafourche Port Commission
- Grand Isle Port Commission
- Plaquemines Port, Harbor and Terminal District
- Port of Baton Rouge
- Port of Iberia District
- Port of New Orleans
- St. Bernard Port, Harbor and Terminal District
- Twin Parish Port Commission

Mississippi
- Port of Gulfport
- State Port Authority

Texas
- Brownsville Navigation District—Port of Brownsville
- Port Freeport
- Port Mansfield/Willacy County Navigation District
- Port of Beaumont
- Port of Corpus Christi Authority
- Port of Galveston
- Port of Houston Authority
- Port of Isabel—San Benito Navigation District
- Port of Port Arthur Navigation District

5.5. PUBLIC HEARINGS

In accordance with 30 CFR 556.26, BOEM scheduled public hearings soliciting comments on the Draft Multisale EIS. The hearings provided the Secretary of the Interior with information from interested parties to help in the evaluation of potential effects of the proposed WPA and CPA lease sales. An announcement of the dates, times, and locations of the public hearings was included in the Notice of Availability for the Draft Multisale EIS. A copy of the public hearing notices was included with the Draft Multisale EIS that was mailed to the parties indicated above, was published in local newspapers, and was posted on BOEM's Internet website at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx.

The hearings were held on the following dates and at the times and locations indicated below:

Tuesday, January 10, 2012
1:00 p.m. CDT until adjournment
Houston Airport Marriott
George Bush Intercontinental
18700 John F. Kennedy Boulevard
Houston, Texas
9 registered attendees
1 speaker

Wednesday, January 11, 2012
1:00 p.m. CDT until adjournment
Bureau of Ocean Energy Management
1201 Elmwood Park Boulevard
New Orleans, Louisiana
4 registered attendees
1 speaker

Thursday, January 12, 2012
1:00 p.m. CDT until adjournment
Five Rivers—Alabama's Delta Resource Center
30945 Five Rivers Boulevard
Spanish Fort, Alabama
14 registered attendees
5 speakers

Houston, Texas, January 10, 2012

One speaker representing industry provided testimony at the public hearing held in Houston, Texas, on January 10, 2012. Matt Harlan of J. Connor Consulting asked what impact-producing factors might have been affected by new information regarding the DWH event.

New Orleans, Louisiana, January 11, 2012

One speaker representing industry provided testimony at the public hearing held in New Orleans, Louisiana, on January 11, 2012. Chris John, representing Louisiana Mid-Continental Oil and Gas Association offered support for Alternative A, the Proposed Action.

Mobile (Spanish Fort), Alabama, January 12, 2012

Five speakers provided testimony at the public hearing held in Mobile (Spanish Fort), Alabama, on January 12, 2012. Kimberly McCuiston of Alabama Oil Spill Aftermath Coalition; David Underhill of Mobile Bay's Sierra Club; John Klotz, a small business owner; Carol Adams-Davis, a local resident; and Daniel Storey, a concerned citizen, provided testimony. Ms. McCuiston stated that her coalition does not want any more lease sales off the coast of the Gulf of Mexico and that renewable fuels need to be developed to replace oil. Mr. Underhill questioned why we are continuing to have lease sales and stated that drilling cannot be safely done. He urged BOEM to study alternative energy, including wave energy. Mr. Klotz questioned the amount of oil and gas needed by the United States and stressed conservation and alternative energy as means to reduce oil consumption. He also noted that safety regulations were in need of improvement and were not followed on the Macondo well. He advocated prison terms for violation of drilling regulations. Ms. Adams-Davis called for a rigorous spill-risk analysis and a delay in drilling until more stringent regulations are in place and until the long-term effects of the DWH event are known. She noted the need for consideration of climate change effects and of shortcomings in drilling regulations. She asked BOEM to develop a state-of-the-art response plan for future spills, to delay leasing, and to improve technology. She stated that government agencies were not up to the task of oil-spill response and were not honest with the public. Mr. Storey reminded everyone of the 11 people who were killed in the DWH event. He emphasized the need for contingency planning for natural gas drilling and asked for the coordination with the Local Emergency Planning Committees.

5.6. Coastal Zone Management Act

If a Federal agency's activities or development projects within or outside of the coastal zone will have reasonably foreseeable coastal effects in the coastal zone, then the activity is subject to a Federal Consistency Determination (CD). To prepare the CD's, BOEM reviews each State's Coastal Management Plan (CMP) and analyzes the potential impacts as outlined in this EIS, new information, and applicable studies as they pertain to the enforceable policies of each CMP. The Coastal Zone Management Act (CZMA) requires that Federal actions that are reasonably likely to affect any land or water use or natural resource of the coastal zone be "consistent to the maximum extent practicable" with relevant enforceable policies of the State's federally approved coastal management program (15 CFR 930 Subpart C). A consistency review will be performed and a CD will be prepared for the affected States prior to a proposed WPA or CPA lease sale.

Based on the analyses, the BOEM Director makes an assessment of consistency, which is then sent to each State with the Proposed Notice of Sale. If a State concurs, BOEM can hold the lease sale. If the State objects, it must do the following under the CZMA: (1) indicate how BOEM's prelease proposal is inconsistent with their CMP and suggest alternative measures to bring BOEM's proposal into consistency with their CMP; or (2) describe the need for additional information that would allow a determination of consistency. Unlike the consistency process for specific OCS plans and permits, there is no procedure for administrative appeal to the Secretary of Commerce for a Federal CD for prelease activities. Either BOEM or the State may request mediation. Mediation is voluntary, and the Department of Commerce would serve as the mediator. Whether there is mediation or not, the final CD is made by DOI, and it is the final administrative action for the prelease consistency process. Each Gulf State's CMP is described in **Appendix F**.

5.7. ENDANGERED SPECIES ACT

The Endangered Species Act of 1973 (ESA) (16 U.S.C. 1631 *et seq*.), as amended (43 U.S.C. 1331 *et seq*.), establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. On July 30, 2010, BOEM reinitiated ESA Section 7 Consultation on the previous 2007-2012 Multisale EIS for the Gulf of Mexico's WPA and CPA with both FWS and NMFS. This request was made as a response to the DWH event and is meant to comply with 50 CFR 402.16, "Reinitiation of formal consultation." At present, BOEM is acting as the lead agency in the ongoing consultation, with BSEE's assistance and involvement. The BOEM, BSEE, NMFS, and FWS are in the process of collecting information in order to update the environmental baseline information as needed for this reinitiated Section 7 consultation.

As BOEM moves forward with the new 2012-2017 Five-Year Program, BOEM and BSEE have established an interim project-specific consultation process with NMFS. The purpose of this coordination is to ensure that NMFS has the opportunity to review exploration, development, and production activities prior to BOEM approval and to ensure that all approved plans and permits contain any necessary measures to avoid jeopardizing the existence of any ESA-listed species or precluding the implementation of any reasonable and prudent alternative measures. On February 8, 2012, NMFS and BOEM finalized an interim ESA process for project-specific consultation procedures that will remain in place until a new biological opinion is completed.

With consultation ongoing, BOEM and BSEE will continue to comply with all Reasonable and Prudent Measures and the Terms and Conditions under these existing consultations, along with implementing the current BOEM and BSEE required mitigation, monitoring, and reporting requirements. Based on the most recent and best available information at the time, BOEM and BSEE will also continue to closely evaluate and assess risks to listed species and designated critical habitat in upcoming environmental compliance documentation under NEPA and other statutes.

5.8. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

Pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act, Federal agencies are required to consult with NMFS on any action that may result in adverse effects to EFH. The NMFS published the final rule implementing the EFH provisions of the Magnuson-Stevens Fisheries Conservation and Management Act (50 CFR 600) on January 17, 2002. Certain OCS activities authorized by BOEM may result in adverse effects to EFH, and therefore, require EFH consultation.

In March 2000, BOEM's Gulf of Mexico OCS Region consulted with NMFS's Southeast Regional Office in preparing a NMFS regional finding for the Gulf of Mexico OCS Region that allows BOEM to incorporate the EFH assessments into NEPA documents. This Agency consulted on a programmatic level by letters of July 1999 and August 1999 to address EFH issues for certain Bureau of Ocean Energy Management OCS activities (i.e., plans of exploration and production, pipeline rights-of-way, and platform removals).

An EFH consultation for the CPA and WPA lease sales included in the Five-Year Program, using the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007; Central Planning Area Sales 185, 190, 194, 198, and 201; Western Planning Area Sales 187, 192, 196, and 200, Draft Environmental Impact Statement* (USDOI, MMS, 2002) as the NEPA document, was initiated in March 2002 by this Agency with NMFS's Southeast Regional Office. The NMFS responded in April 2002, endorsing the implementation of resource protection measures previously developed cooperatively by this Agency and NMFS in 1999 to minimize and avoid EFH impacts related to exploration and development activities in the CPA and WPA. In addition to routine measures, additional conservation recommendations were made. In May 2002, this Agency responded to NMFS, acknowledging receipt and agreement to follow the additional conservation recommendations. The EFH conservation measures recommended by NMFS serve the purpose of protecting EFH. Continuing agreements, including avoidance distances from the topographic features' No Activity Zones and live-bottom pinnacle features, as well as circumstances that require project-specific consultation, appear in the clarifying provisions of NTL 2004-G05.

Effective January 23, 2006, NMFS modified the identification and descriptions of EFH. One of the most important changes noted in the amendment is the elimination of the EFH description and identification from waters between 100 fathoms and the seaward limit of the Economic Exclusion Zone.

Further programmatic consultation was initiated and completed for the Five-Year Program's lease sales included in the 2007-2012 Multisale EIS. The NMFS concurred by letter dated December 12, 2006, that the information presented in the 2003-2007 Draft Multisale EIS satisfies the EFH consultation procedures outlined in 50 CFR 600.920 and as specified in NMFS's March 17, 2000, findings. Provided that BOEM's proposed mitigations, NMFS's previous EFH conservation recommendations, and the standard lease stipulations and regulations are followed as proposed, NMFS agrees that impacts to EFH and associated fishery resources resulting from activities conducted under the 2007-2012 Five-Year Program's lease sales would be minimal. Following the DWH event, on July 30, 2010, BOEMRE requested reinitiation of ESA consultation with both NMFS and FWS. The NMFS responded with a letter to BOEMRE on September 24, 2010. The EFH consultation was also addressed in NMFS's letter. The new consultation for this Multisale EIS (2012-2017) will include an EFH assessment (**Appendix D**) and BOEM consultation initiation, NMFS comment, and BOEM response letters. The EFH is also addressed in **Chapters 4.1.1.15 and 4.2.1.18**.

5.9. National Historic Preservation Act

In accordance with the National Historic Preservation Act (NHPA) (16 U.S.C. 470) Federal agencies are required to consider the effect of their undertakings on historic properties. The implementing regulations for Section 106 of the NHPA (16 U.S.C. 470f), issued by the Advisory Council on Historic Preservation (16 CFR 800), specify the required review process. The BOEMRE initiated a request for consultation with the affected Gulf States and Tribal Nations on November 12, 2010, via a formal letter. A timeline of 30 days was provided and two responses were received.

The State of Louisiana, in a letter to BOEMRE dated December 16, 2010, indicated that no known historic properties will be affected by this undertaking and that consultation regarding the proposed actions is not necessary. The Seminole Tribe of Florida-Tribal Historic Preservation Officer (STOF-THPO) responded to BOEMRE's request for consultation on December 6, 2010. The STOF-THPO indicated that there was no objection to the proposed undertakings at this time. The STOF-THPO requested to review the impending remote-sensing survey reports that are to be conducted over the high-probability zones within the project area. Additionally, the STOF-THPO requested to be notified if cultural resources that are potentially ancestral or historically relevant to the Seminole Tribe of Florida are inadvertently discovered at any point during this process. Neither of these responses requested consultation. No further responses were received beyond the 30-day timeline and no further requests for consultation were received.

This Section 106 consultation is concluded at this time. The BOEM will continue to impose mitigating measures, and monitoring and reporting requirements to ensure that historic properties are not affected by the proposed undertakings. The BOEM will reinitiate the consultation process with affected parties should such circumstances warrant further consultation.

5.10. Major Differences Between the Draft and Final Multisale EIS's

Comments on the Draft Multisale EIS were received during the public hearings and were also received via written and electronic correspondence. The BOEM received 2,501 emails in response to the Draft Multisale EIS. As a result of these comments, changes have been made between the Draft and Final Multisale EIS's. Where appropriate, the text in the Final Multisale EIS has been revised or expanded to provide clarification on specific issues, as well as to provide updated information. In addition, between the Draft and Final Multisale EIS's, BOEM continued to update information and data relied on in this document and removed information determined to be irrelevant for the WPA and CPA proposed actions. None of the revisions between the Draft and Final Multisale EIS's changed the impact conclusions for the physical, environmental, and socioeconomic resources analyzed in the EIS.

5.11. Letters of Comment on the Draft Multisale EIS and BOEM's Responses

The Notice of Availability and announcement of public hearings were published in the *Federal Register* by BOEM on December 30, 2011 (USEPA Notice of Availability publication date, December 30, 2011), were posted on BOEM's Internet website, and were mailed to interested parties.

The comment period ended on February 15, 2012. The BOEM received 2,501 emails in response to the Draft Multisale EIS. The vast majority of the emails contained comments similar to those in the letter from J. Capozzelli. Fifteen comment letters were received from the public and private agencies and groups listed below:

Federal Agencies
- Department of Commerce
  - National Oceanic and Atmospheric Administration
- Department of the Interior
  - Fish and Wildlife Service
- Environmental Protection Agency
- Marine Mammal Commission

State Agencies and Representatives
- Alabama Department of Environmental Management
- Louisiana Department of Natural Resources
- Texas Commission on Environmental Quality

Local Agencies
- No comments were received

Organizations and Associations
- American Petroleum Institute
- Center for Regulatory Effectiveness
- Mobile Baykeeper and Waterkeeper Alliance
- Oceana

Industry
- ConocoPhillips

General Public
- J. Capozzelli
- John Klutz

Copies of these letters are presented on the subsequent pages. Each letter’s comments have been marked for identification purposes. The BOEM’s responses immediately follow each letter.

MARINE MAMMAL COMMISSION

15 February 2012

Mr. Gary D. Goecke
Chief, Regional Assessment Section
Office of the Environment
Gulf of Mexico Outer Continental Shelf Region
Bureau of Ocean Energy Management
1201 Elmwood Park Boulevard, MS-5410
New Orleans, LA 70123-2394

Dear Mr. Goecke:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed (1) the Bureau of Ocean Energy Management's draft environmental impact statement on the Gulf of Mexico Outer Continental Shelf proposed 2012-2017 oil and gas lease sales for the Western and Central Planning Areas and (2) the associated 30 December 2011 *Federal Register* notice (76 Fed. Reg. 82319).

The Commission provided a number of recommendations in response to the notice of intent to prepare an environmental impact statement for the 2007-2012 Gulf of Mexico leasing program (enclosed). Those recommendations are submitted again for the Bureau's consideration and action. To supplement those recommendations, the Commission provides the following additional recommendations and rationale.

RECOMMENDATIONS

The Marine Mammal Commission recommends that the Bureau of Ocean Energy Management—

- review the Commission's enclosed statement of research needs, consult with the National Oceanic and Atmospheric Administration, the Fish and Wildlife Service, and the Marine Mammal Commission on long-term, high priority research and monitoring needs related to the Deepwater Horizon oil spill, and incorporate those priorities into its Environmental Studies Program;
- work with the National Marine Fisheries Service, the Fish and Wildlife Service, academia, and industry partners to develop a comprehensive monitoring program for the Gulf of Mexico ecosystem, including its marine mammal populations; and
- revise its environmental impact statement to include alternative strategies for seismic studies that would provide opportunities for avoiding unnecessary redundancy and thereby minimizing the associated ecosystem disturbance.

Investigating long-term oil spill effects

The April 2010 explosion of BP's Deepwater Horizon offshore drilling unit in the Gulf of Mexico resulted in an oil spill with significant ecological, social, and economic consequences. Achieving a full understanding of the spill's effects likely will require years of assessment because

some effects may continue or worsen, whereas others may not yet have been realized or become apparent.

A full accounting of the spill's effects on wildlife is not possible because of the lack of pre-spill baseline information. In the Gulf, the lack of such information for marine mammals has been and continues to be a serious and longstanding problem. One of the major lessons of the *Exxon Valdez* oil spill was that assessing spill effects requires good baseline information (Loughlin 1994, Matkin et al. 2008). Now, two decades later, the evidence indicates that lesson still has not been heeded. Of the 57 marine mammal stocks identified in the Gulf, baseline information is adequate for only a handful of them.

The lack of baseline information for the majority of Gulf marine mammal stocks, and research capacity generally, is related largely to inadequate research funding, personnel, and infrastructure (e.g., research vessels, analytical laboratories). As a result, studies to assess the long-term effects of the Deepwater Horizon oil spill likely will be hampered by inadequate resources and, if the past is any indication of the future, focused on a small subset of the Gulf's marine mammals (i.e., bottlenose dolphins and sperm whales).

Such assessments also will be confounded by the many other human activities and natural phenomenon that affect the Gulf—seismic surveys and routine oil and gas operations, commercial and recreational fisheries, commercial shipping, coastal development, military activities, tourism, hypoxia and anoxia, harmful algal blooms, hurricanes, natural oil seeps, and climate disruption. Undoubtedly, distinguishing the effects of those risk factors from the effects of the spill on the Gulf's marine ecosystem will be a challenge. However, that does not lessen the responsibility of the regulating federal agencies for trying to doing so.

To facilitate assessment of the long-term effects of the Gulf spill, the Commission has prepared the enclosed report, "Assessing the Long-term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs." The Commission prepared the report with input from scientists and managers from the Bureau, the National Oceanic and Atmospheric Administration, and the Fish and Wildlife Service. The report outlines the legal mandates for assessing a spill's overall effects and details the likely effects of oil spills on marine mammals. It characterizes research efforts to date, highlights the overall need to improve assessment and monitoring of the Gulf's marine mammals, and outlines priorities for future efforts. Although virtually all assessment and monitoring efforts should be given high priority during or immediately after a spill, the likelihood of detecting certain impacts decreases with time and the utility and value of certain types of research declines accordingly. Therefore, the statement of research needs gives highest priority to tasks aimed at understanding potential long-term effects, including (1) assessing the health status of stranded or live-captured animals; (2) assessing oil spill-related changes in the ecosystem leading to a potential reduction in prey availability; (3) evaluating other ecosystem changes that are harmful to marine mammals and that may have been exacerbated by the spill (e.g., harmful algal blooms, hypoxia or anoxia); and (4) determining the extent to which exposure to oil and/or response activities leads to a reduction in status involving individual animal fitness, population vital rates (survival and reproduction), and population abundance and trends.

Mr. Gary Goecke
15 February 2012
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The Commission developed this statement of research needs to help guide the Bureau and other regulatory agencies as they develop plans to assess the long-term effects of the Gulf spill. The Marine Mammal Commission recommends that the Bureau of Ocean Energy Management review the Commission's enclosed statement of research needs, consult with the National Oceanic and Atmospheric Administration, the Fish and Wildlife Service, and the Marine Mammal Commission on long-term, high priority research and monitoring needs related to the Deepwater Horizon oil spill, and incorporate those priorities into its Environmental Studies Program.

Comprehensive monitoring program

Many of the shortcomings in our understanding of spill effects reflect an inadequate monitoring program for oil and gas activities generally. As a nation, we cannot make a legitimate claim to be science-based in our management of natural resources if we do not commit to comprehensive monitoring of our unintended but potentially significant effects on the marine environment. A comprehensive monitoring program should be sufficient to identify and avoid potential harmful interactions with sensitive populations (e.g., those listed as threatened or endangered under the Endangered Species Act or depleted under the Marine Mammal Protection Act) and impacts on particularly sensitive areas. For potentially affected marine mammals, the necessary information includes their stock structure, population status, abundance and trends, distribution and seasonal movements, habitat use patterns, and trophic relationships. A comprehensive monitoring program also should be collected at temporal and spatial scales necessary to characterize the inherent variability in the affected ecosystems. Indeed, the collection of baseline information requires a long-term commitment of effort and resources to provide the knowledge needed to detect or determine the extent of adverse effects associated with oil and gas development and otherwise provide a strong foundation for responsible management of marine ecosystems.

In fact, the Bureau's Environmental Studies Program has committed significant resources to comprehensive, multi-agency, multi-year programs to collect data on the abundance and seasonal distribution of certain marine mammals and other wildlife in the U.S. Atlantic and Arctic, areas targeted for development of new domestic energy sources. The Commission commends those efforts. The investment in research and monitoring in the Gulf of Mexico pales in comparison, which is remarkable because the Gulf has been, is, and will remain for the foreseeable future, the most important U.S. region for offshore oil-production.

The Commission believes that the Bureau must commit to a long-term, comprehensive monitoring program in the Gulf if it is to ensure that the Gulf's marine environment is adequately protected from the adverse effects of oil and gas production. Clearly, the Bureau cannot be solely responsible and such a program must be coordinated with the National Marine Fisheries Service, the Fish and Wildlife Service, academia, and industry partners. The program should include a strategy for assessing the status of marine mammal populations, characterizing important natural history traits including habitat use, determining vulnerability to threats from oil and gas activities, and identifying and developing appropriate mitigation and monitoring measures. A number of research tools are available for collecting this information, including vessel and aircraft surveys, passive acoustics, telemetry tagging, biopsy sampling, photo-identification studies, and information obtained from stranded animals. Therefore, the Marine Mammal Commission recommends that the Bureau

Mr. Gary Goecke
15 February 2012
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of Ocean Energy Management work with the National Marine Fisheries Service, the Fish and Wildlife Service, academia, and industry partners to develop a comprehensive monitoring program for the Gulf of Mexico ecosystem, including its marine mammal populations.

Minimizing duplicative seismic surveys

In the course of oil and gas operations, seismic surveys are used for at least four purposes: (1) to explore broadly for oil and gas reservoirs, (2) to investigate in detail an area where exploratory drilling may be attempted, (3) to guide drilling activities, and (4) to monitor changes in reservoirs as extraction proceeds. These surveys are among the most disturbing oil and gas activities, particularly for organisms such as marine mammals, as they introduce extensive sound energy into the water. The amount of disturbance is a function of multiple factors, including the frequency and intensity of surveys conducted in a particular area.

Currently, each oil and gas company either conducts its own seismic surveys or contracts with another company to conduct the surveys on its behalf. If multiple companies are interested in the same or adjacent areas, then, over the course of oil and gas development, a given area may be surveyed on multiple occasions, thereby generating unnecessary, redundant data. In essence, the lack of coordination in conducting surveys and the failure to share the resulting data may be causing unnecessary disturbance to ecosystems and their associated biological communities. In other words, marine seismic surveys are not being managed to achieve the least practicable environmental impact.

MMC-1

With that concern in mind, the Marine Mammal Commission recommends that the Bureau of Ocean Energy Management revise its environmental impact statement to include alternative strategies for seismic studies that would provide opportunities for avoiding unnecessary redundancy and thereby minimizing the associated ecosystem disturbance.

Please contact me if you have questions about the Commission's recommendations or comments.

Sincerely,

Timothy J. Ragen, Ph.D.
Executive Director

Enclosures (3)

cc: David Bernhart, National Marine Fisheries Service
Deborah Epperson, Bureau of Ocean Energy Management
David Hankla, Fish and Wildlife Service

Mr. Gary Goecke
15 February 2012
Page 5

References

Loughlin, T. (ed.). 1994. Marine mammals and the *Exxon Valdez*. Academic Press, San Diego, CA, 395 pages.

Matkin, C.O., E.L. Saulitis, G.M. Ellis, P. Olesiuk, and S.D. Rice. 2008. Ongoing population-level impacts on killer whales *Orcinus orca* following the '*Exxon Valdez*' oil spill in Prince William Sound, Alaska. Marine Ecology Progress Series 356:269-281.

Marine Mammal Commission

MMC-1 While BOEM does undertake studies on a number of resources and issues related to the OCS, the decisions made on which studies to fund and pursue are outside of the scope of this EIS. The BOEM is working with NMFS on an EIS for seismic activities in the GOM. Alternative technologies as well as other strategies to minimize potential impacts to resources will be evaluated as part of this NEPA process.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
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http://sero.nmfs.noaa.gov/

FEB 15 2012 F/SER4:DD

Mr. Gary D. Goeke
Regional Assessment Section
Office of Environmental (MS 5410)
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Dear Mr. Goeke:

Enclosed are NOAA's National Marine Fisheries Service comments in response to the December 29, 2011, Notice of Availability of the draft Environmental Impact Statement for the Outer Continental Shelf (OCS) Oil and Gas Leasing Program: 2012-2017 in the Western Planning and Central Planning Areas of the Gulf of Mexico.

Consultations under section 7 of the Endangered Species Act and Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act will be completed under separate correspondence.

Thank you for your consideration of our comments. If we can be of further assistance, please do not hesitate to contact David Dale of my staff at 727-824-5317 or by email at david.dale@noaa.gov.

Sincerely,

Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure

cc: (w/encl.) via electronic mail
F – McCune, Leathery, Holmes
F/SER – Keys, Silverman
F/SER4 – Fay, Dale
F/SER3 – Bernhart, Baker

NOAA'S NATIONAL MARINE FISHERIES SERVICE
SOUTHEAST REGIONAL OFFICE

NATIONAL ENVIORNMENTAL POLICY ACT COMMENTS ON
U.S. DEPARTMENT OF INTERIOR/BUREAU OF OCEAN ENERGY MANAGEMENT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE GULF OF MEXICO OUTER CONTINENTAL SHELF
OIL AND GAS LEASE SALES 2012-2017
Western Planning Area Lease Sales 229, 233, 238, 246, and 248
Central Planning Area Lease Sales 227, 231, 235, 241, and 247

February 2012

BACKGROUND

The Department of Interior's Bureau of Ocean Energy Management (BOEM), Gulf Of Mexico Outer Continental Shelf (OCS) Region prepared a draft environmental impact statement (DEIS) for the Gulf of Mexico OCS Western and Central Planning Area Oil and Gas Lease Sales for 2012-2017. Five annual lease sales are scheduled for each planning area.

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act; 16 U.S.C. §1801 et seq.) requires Federal agencies to consult with the Secretary of Commerce, through NOAA's National Marine Fisheries Service (NMFS), with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat (EFH) identified under this Act." 16 U.S.C. § 1855(b)(2). Under the Outer Continental Shelf Lands Act (OCSLA; 43 U.S.C. § 1331 et seq), the BOEM is responsible for leasing tracts of the OCS for oil and gas exploration, development, and production. Certain OCS activities authorized by BOEM may result in adverse impacts to EFH, and therefore require EFH consultation. Actions taken by BOEM under the OCSLA are evaluated through NEPA. BOEM (formerly the Minerals Management Service) and NMFS cooperatively developed modified procedures to incorporate EFH consultation into existing NEPA processes by findings letters dated March 17, 2000, and March 12, 2002. Our agencies consulted on a programmatic level by letters dated June 4, 1999, July 1, 1999, and August 12, 1999, to address EFH issues related to operational activities, including pipeline rights-of-way, plans for exploration and production, and platform removal in the Gulf of Mexico Central and Western Planning Areas. That programmatic EFH agreement was subsequently amended by a letter dated July 19, 2007, to also include operational activities within a small portion of the Eastern Planning Area.

Following the Mississippi Canyon 252 event in April 2010, BOEM requested re-initiation of Endangered Species Act consultation with both the U.S. Fish and Wildlife Service and NMFS. NMFS responded by letter dated September 24, 2010, requesting a periodic review of the EFH consultation as well. Regional NMFS and BOEM staff agreed to procedures which would incorporate a new programmatic EFH consultation into the EIS prepared for each five-year multi-lease sale program beginning with the 2012-2017 program. BOEM has included a draft EFH Assessment as Appendix D to the DEIS, and in accordance with the agreed procedures, separate correspondence will be provided to complete the EFH Consultation between the BOEM Gulf of Mexico OCS Region and the NMFS Southeast Region Habitat Conservation Division.

GENERAL COMMENTS

NMFS-1

Section D.3. Habitats. (page D-6): In the third paragraph "NMFS Southeast Region" should be corrected. Additionally, this paragraph contains language associated with consultations conducted under Section 7 of the Endangered Species Act. We recommend the sixth sentence be modified to read as follows: "Based on the most recent and best available information at the time, BOEM will also continue to closely evaluate and assess risks to managed species and identified EFH in upcoming environmental compliance documentation under NEPA and other statutes."

NMFS-2

Section D.3. Structural Habitats. (page D-7): The Gulf of Mexico Fishery Management Council did not identify and describe manmade structures as EFH in the Gulf of Mexico. The status of manmade structures as EFH should be clarified if this summary discussion is retained in Appendix D.

NMFS-3

The NMFS repealed the fishery management plan (FMP) for stone crab in the Gulf of Mexico effective October 24, 2011. References to stone crab can be removed from:

- Section 4.1.1.15.1 Essential Fish Habitat (page 4-305) First paragraph; sixth sentence.
- Section 4.2.1.18.1 Essential Fish Habitat (page-839): First paragraph; sixth sentence.
- Section D.4. Fisheries (page D-9): opening sentence.
- Section D.4. Fisheries (page D-10: the paragraph titled "Stone Crab"

NMFS-4

Table D-1 Managed Species in the Gulf of Mexico: The "Other Species of Importance" are not managed by NMFS under the Magnuson-Stevens Act and should be removed from Table D-1. The Gulf of Mexico Fishery Management Council removed several species from federal management effective January 2012. In addition to stone crab, the following should be removed from Tables D-1, D-2, D-3, and D-4: dog snapper, mahogany snapper, schoolmaster, misty grouper, red hind, rock hind, blackline tilefish, anchor tilefish, dwarf sand perch, sand perch, bluefish, cero, dolphin, little tuny, and slipper lobster. Additionally, we recommend the remaining invertebrates be separated into their respective FMPs (i.e., Shrimp and Spiny Lobster).

National Marine Fisheries Service

NMFS-1 The BOEM made the requested edits in the Final Multisale EIS.

NMFS-2 The BOEM agrees and has moved the paragraph to the end of the section and has added clarifying language to reduce confusion.

NMFS-3 Comment noted. The recommended change was made to the text.

NMFS-4 In **Table D-1**, "Other Species of Importance" was removed. "Shrimp Fishery" and "Spiny Lobster Fishery" were added as headings in the table as requested. Likewise, mention of stone crab, dog snapper, mahogany snapper, schoolmaster, misty grouper, red hind, rock hind, blackline tilefish, anchor tilefish, dwarf sand perch, sand perch, bluefish, cero, dolphin, little tunny, and slipper lobster were removed from **Tables D-1 through D-4**.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

February 15, 2012

To: Chief, Environmental Assessment Section
Leasing and Environment (MS 5410)
Bureau of Ocean Energy Management, Regulation and Enforcement
Gulf of Mexico Outer Continental Shelf (OCS) Region
New Orleans, Louisiana

From: Supervisor
Fish and Wildlife Service
Louisiana Ecological Services Office
Lafayette, Louisiana

Subject: Draft Programmatic Environmental Impact Statement for the Proposed 2012-2017 OCS Oil and Gas Lease Sales in the Gulf of Mexico Western and Central Planning Areas

The Fish and Wildlife Service (Service) has reviewed the subject Draft Programmatic Environmental Impact Statement (DPEIS) for the 2012-2017 Outer Continental Shelf (OCS) Oil and Gas Lease Sales in the Gulf of Mexico Western Planning Area (WPA) and Central Planning Area (CPA), administered by the Bureau of Ocean Energy Management (BOEM), Gulf of Mexico OCS Region. Comments regarding the DPEIS are provided below by the Louisiana Ecological Services Office in behalf of the Service's Southeast Region and are specific for the CPA in accordance with provisions of the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d), Migratory Bird Treaty Act (MBTA) (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.) and the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) (104 Stat. 4779; 16 U.S.C. 3951 et seq.). This response does not address any ESA section 7 consultation issues that may apply to this action.

FWS-1

As in previous documents, we note your reference to the new policies and regulations created in response to the *Deepwater Horizon* (DWH) event that are designed to reduce the likelihood of another catastrophic spill occurring and improve spill response if such an event were to occur again. Spill response and clean-up efforts continue and the effects to natural resources, such as wetlands, coastal barrier beaches, migratory birds and threatened and endangered species have yet to be fully realized. Therefore, when reporting impacts of the DWH spill and response activities, please provide the most up-to-date information available at the time of document publication. As you describe or reference the Oil Spill Risk Analysis (OSRA) model results throughout the document, we believe it would be appropriate to identify when the model was run (e.g., for the proposed action or for the previous 5 year lease sale program) and how current the model inputs are.

FWS-2

If BOEM believes a multiday, catastrophic spill could generate reasonably foreseeable impacts to natural resources, as stated in Appendix B, we suggest BOEM evaluate the effects of such an event on species that may be impacted if oil from such a catastrophic spill were to enter the Loop Current and oil peninsular Florida. Additional species we recommend you consider in the DPEIS or any future biological assessments, depending on the extent and probability of potential oiling, include the threatened American crocodile (*Crocodylus acutus*) and its critical habitat, the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) and its critical habitat and two candidate species – the aboriginal pricklyapple (*Harrisia aboriginum*) and the Cape Sable thoroughwort (*Chromolaena frustrata*). Otherwise, we recommend you explain why those species do not need impact assessments. Information for those species may be obtained by contacting our Ecological Services field office in Vero Beach, Florida, at 771-562-3909. You can also access their website at www.fws.gov/verobeach for more information as well. Page-specific comments follow.

Specific Comments

FWS-3

Page xiii: When summarizing impacts to birds, please clarify the phrase "… are expected to be adverse, but not significant." The phrase in its present form appears to be contradictory.

FWS-4

Page 2-55: We recommend you briefly describe the sea turtle stranding event referenced in paragraph 5, third sentence.

FWS-5

Page 2-57: Please cite your source of the referenced <0.5 percent predicted probability of an oil spill contacting beach mice in paragraph 4, third sentence.

FWS-6

Page 2-58: We recommend you add the following language to the end of the third paragraph: "One avoidance measure available is the use of lights with less red and more green in the light spectrum. Such actions reduce avian nocturnal circulation." Due to the potential and documented impacts that oil and gas platforms have on migrating birds (*e.g.*, bird strikes and nocturnal circulations), we strongly recommend that BOEM require that the use of red lighting on OCS oil and gas platforms be greatly reduced or eliminated in the Gulf of Mexico and replaced with lights of other colors, such as green. If that is not feasible, we recommend strobe lights and directed / down-shielded low sodium lights be installed on all Gulf of Mexico OCS platforms.

FWS-7

Page 2-59: The second paragraph references Figure 3-22 when describing spill impacts to the threatened gulf sturgeon (*Acipenser oxyrinchus desotoi*) and its critical habitat. However, the figure does not accurately reflect critical habitat boundaries for the gulf sturgeon. Please navigate to the internet address http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E04W#crithab for links to the Final and Proposed Rule for gulf sturgeon critical habitat that contain the correct boundaries. Using the more accurate boundaries may change the OSRA model results.

FWS-8 Page 2-66: Please identify which species you are referencing in the first and second paragraph when you say "…the above-mentioned species."

FWS-9 Pages 3-3 and 3-4: We recommend you briefly describe Lease Sales 225 and 226 in the Eastern Planning Area (EPA) in the Summary and preceding chapters before Chapter 3 to more fully disclose potential actions and impacts in the Gulf of Mexico. Chapter 3 is the first time you mention the potential EPA lease sales in the document.

FWS-10 Page 3-5: If production of oil and gas will continue more than 40 years from the time of a lease sale (as stated in the last sentence of paragraph 5), then we recommend your assessment of proposed action impacts be projected past the currently used 40-year analysis period (see paragraph 6, first sentence).

FWS-11 Page 3-32: We suggest you recalculate and report the total amount of oil spilled for all regions from 1989 to 1997 without the amount of oil spilled from the *Exxon Valdez* vessel rupture (a statistical outlier), as is found in the first paragraph. Doing so should provide a better comparison of typical spill rates in recent history to more current times (1998 to 2007). An explanation for the recalculation should also be provided in the document.

FWS-12 Page 3-34: We recommend you present in tabular form the source breakdown of reported coastal spills in paragraph two. This would assist reviewers in understanding the information.

FWS-13 Page 3-34: Please clarify the first and second sentences in paragraph five. In their current form, they appear to contradict each other.

FWS-14 Pages 3-39 and 3-42: We recommend you reconsider the efficacy of using 2010 data when documenting trends in OCS activity (*e.g.*, for barges on page 3-39 and helicopter operations on page 3-42). Due to the DWH spill response and subsequent temporary freeze of certain activities, certain 2010 data may be anomalous.

FWS-15 Page 3-57: To help BOEM better quantify and assess impacts of coastal spills in relation to OCS activities, we suggest you regularly collect information on State pollution incidents. The third sentence of paragraph five states BOEM occasionally collects such data.

FWS-16 Page 3-59: Please clarify the statement "Only spills ≥1,000 bbl are addressed using OSRA because smaller spills *may* [emphasis added] not persist long enough to be simulated by trajectory modeling." Using the word "may" suggests that some spills <1,000 bbl could persist. If so, then those spills should be included in the trajectory model.

FWS-17 Page 3-65: We recommend you explain why you use only 14 years of recently reported coastal spills (1996-2009) in your risk analysis for coastal spills (see the first and second sentence).

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FWS-18 Page 3-72: Regarding your statement in the fourth paragraph that dispersant application may be preferred in deepwater settings (implying subsea application), the Service supports the development of new tools to reduce the environmental impacts from oil spills. However, we do not believe that adequate information has been made available for us to conclude or agree with any statement that subsea dispersant injection is a preferred method of responding to an oil spill. Until the potential environmental consequences of subsea dispersant use have been rigorously evaluated under a variety of application scenarios, the Service recommends that BOEM continue to require OCS operators demonstrate the ability to deploy adequate subsea physical containment technologies, as discussed on pages 4-78 through 4-79 of the draft environmental impact statement for the 2012-2017 regionwide OCS oil and gas lease program.

FWS-19 Page 3-80: We support measures that would reduce the chance of future spills or blowouts from occurring. For example, in the sixth paragraph, we strongly recommend BOEM consider requiring double ram configurations on all, or at least on deepwater, blowout preventers (BOPs). BOEM currently does not have this requirement.

FWS-20 Pages 3-99, fourth paragraph and 3-102, second and third paragraphs: We recommend you update these paragraphs with the following information. The CWPPRA Task Force has approved 187 projects since 1990, but 35 have been deauthorized or transferred. This leaves a total number of 152 "active" projects either constructed or in the engineering and design stage.

FWS-21 Page 3-99: Please update the fourth sentence of the last paragraph. The Mississippi River Gulf Outlet has been closed (see p. 3-101) and is no longer maintained by the Army Corps of Engineers.

FWS-22 Page 3-100: We recommend you replace the word "sub-perpendicular" in the last sentence of paragraph one with a more familiar description or meaning (*e.g.*, "oriented toward").

FWS-23 Page 3-101: Please revise the first sentence of the last paragraph to read "… ongoing program of relatively small to medium projects to partially restore …." For your information, CWPPRA project costs range from $10 million to over $50 million dollars, with a current average cost of approximately $25 million to $30 million dollars. This information would be useful in your discussion of coastal restoration programs.

FWS-24 Page 4-436: Please replace the reference to Figure 4-1 in the third paragraph with Figure 4-2. We believe Figure 4-2 is a more appropriate map to use when discussing bays and estuaries in the Gulf of Mexico.

FWS-25 Page 4-721: We provide the following information that would be useful for your present and future impact analyses to sea turtles.

Florida - Florida's 2011 statewide nesting beach data are still being verified. However, nesting data from previous years and other sea turtle data is available on the following Florida Fish and Wildlife Conservation Commission website: http://myfwc.com/

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research/wildlife/sea-turtles/nesting/. For any specific nesting information not on the website, contact Anne Meylan or Beth Brost at 727-896-8626.

Alabama - Annual nesting numbers for Alabama are summarized on the website http://www.alabamaseaturtles.com/nesting-season-statistics/. Additional sea turtle information may also be found at http://www.seaturtle.org/tracking/?project_id=627A, a website maintained by seaturtle.org, a nongovernmental organization.

Mississippi - Regular nesting surveys are not conducted in Mississippi due to logistical issues and funding limitations. Prior to 2006, the National Park Service annually conducted aerial sea turtle nesting surveys once a week during the nesting season on the Mississippi District of Gulf Islands National Seashore. Aerial surveys were conducted over Cat, Horn, West Ship, East Ship, and Petit Bois Islands. Surveys of sea turtle nesting in Mississippi are no longer being conducted. Historically, the total number of nests for a season ranged from 0 to approximately 15, although aerial survey methods and frequency may have missed nests. Petit Bois and Horn Islands had the most nests; the other islands had occasional nests. All nests sighted during aerial surveys appeared to be loggerhead sea turtles (*Caretta caretta*), but it is possible some may have been Kemp's ridley sea turtle (*Lepidochelys Kempii*) nests. Kemp's ridley turtles were observed in the nearshore waters and stranded on the beach. Leatherback sea turtles (*Dermochelys coriacea*) were also observed in nearshore waters, often associated with jellyfish. There were six incidents of hatchlings found on Mississippi beaches during the 2010 nesting season. Thus, any hatchlings produced from nests laid in these unsurveyed areas had a high risk of being exposed to and injured by oil and dispersants, as well as the response activities for the DWH spill. There was another report of one nest at a beach in Fontainebleau, Mississippi, where only shelled eggs were uncovered.

Louisiana – There have been sporadic reports of sea turtle nesting on islands from the 1930s to the 1980s. In 1960, 31 crawls were observed on the Chandeleur islands (29). In 1972, 7 crawls were reported and in 1977, 4 crawls were reported. In 1986, 13 crawls were observed on Breton Island. In 1989, 17 crawls were observed during one aerial and ground survey. In 1990, 5 crawls were observed during the study period. Regular nesting surveys have not been conducted in Louisiana since 1990. Stranding response reports have documented adult size loggerheads, green (*Chelonia mydas*), leatherbacks, and Kemp's Ridley turtles on Louisiana beaches during the nesting season. One leatherback was observed nesting in 1989 about 2 km (1.24 miles) from the northern end of Chandeleur Island. There was one observation of a possible sea turtle nest/crawl of an unknown species on the Chandeleur Island berm in June 2011. You may contact this office if you would like copies of those reports. Please contact Mandy Tumlin (225-765-2377; mtumlin@wlf.louisiana.gov) for further information regarding sea turtle nesting and stranding in Louisiana.

Texas – Recent annual nesting numbers for Texas are summarized on the websites http://www.nps.gov/pais/naturescience/nesting2010.htm (for 2010) and http://www.nps.gov/pais/naturescience/current-season.htm (for 2011). For more historic nesting data for Texas, contact Donna Shaver with the National Park Service at (361) 949-8173 ext. 226.

FWS-26 Page 4-730: In the second paragraph, please indicate that Kemp's Ridley sea turtle nests have increased significantly in recent years along South Padre Island National Seashore in Texas. For nesting numbers, please contact Donna Shaver with the National Park Service at (361) 949-8173 ext. 226.

FWS-27 Page 4-731: In the last paragraph, fourth sentence, we recommend you remove the repeated phrase "… and 1 Kemp's ridley nest …." It is not relevant when reporting nest numbers for the loggerhead sea turtle.

FWS-28 Page 4-735: We suggest you highlight the State of Mississippi, which has the highest number of recent sea turtle strandings (275 as of October 6, 2011) rather than Alabama. Therefore, replacing the phrase "… Alabama represents approximately 18 percent …" in the eighth sentence of paragraph two with "… Mississippi represents approximately 59 percent …" is recommended.

FWS-29 Page 4-745: In the third paragraph, we recommend you replace the reference to Figure 3-9, which maps oil spill probabilities from a WPA action, with Figure 3-10, which maps oil spill probabilities from a CPA action. That discussion is specific to a CPA action.

FWS-30 Page 4-757: When describing the species status of diamondback terrapins (*Malaclemys terrapin* ssp.) in the first paragraph, please clarify to the reader that they are not federally listed species (*i.e.*, neither threatened nor endangered). The current repeated use of the term "listed November 15, 1994" could lead readers to believe that diamondback terrapins are federally listed. In the third paragraph, we recommend you provide the scientific name for the Florida diamondback terrapin for discussion clarity and consistency. Multiple subspecies of diamondback terrapin occur within Florida.

FWS-31 Page 4-757: We suggest you reword the first sentence of the fifth paragraph which states "… although minimal oil … reached the waters of the CPA." Since the DWH spill originated in CPA waters, all of the oil reached or occurred in the CPA.

FWS-32 Page 4-763: We recommend you replace the reference "… USDOI, FWS (2010h) …" with a more appropriate citation when discussing beach mice critical habitat. The subject reference is for live bird recovery locations.

FWS-33 Page 4-779: As part of the impact assessment for coastal and marine birds, we suggest BOEM assess impacts of the proposed project to the candidate species red knot (*Calidris canutus rufa*) either in the subject document or in future biological assessments for the proposed project. Although BOEM correctly states in the sixth paragraph that red knots may not warrant the same level of impact assessment as listed species, the Service anticipates finalizing the listing process for all candidate species within six years. Therefore, we recommend that the red knot receive the same level of detailed analysis as other listed coastal and marine species under the ESA. Red Knots migrate through and winter along the gulf coast from Texas to Florida and use very similar habitat as the piping plover. Please contact Annette Scherer with our Ecological Services field office in Pleasantville, New Jersey, at 609-646-9310 or access their website at http://www.fws.gov/northeast/njfieldoffice/ for further information.

FWS-34 Page 4-779 and Table 4-14: Please note that only interior nesting populations of the least tern (*Sterna antillarum*) greater than 50 miles from the coast or north of Baton Rouge, Louisiana, in the Mississippi River drainage are endangered (*i.e.*, the coastal birds are not federally listed). Therefore, project impacts to least terns that occur on the coast may be assessed similarly as with other migratory birds protected by the MBTA. We inadvertently included least tern in our February 11, 2011, preliminary species list to you.

FWS-35 Page 4-780: In the second sentence of the last paragraph, please update the number of piping plover critical habitat units in Texas to 18 units. Information on revised piping plover critical habitat in Texas may be found at http://www.gpo.gov/fdsys/pkg/FR-2009-05-19/pdf/E9-11245.pdf#page=1.

FWS-36 Page 4-781: Please revise the first sentence of paragraph two which incorrectly states that effects to the threatened piping plover (*Charadrius melodus*) and its critical habitat from the 2007-2012 Gulf of Mexico oil and gas lease sale program were assessed in a Service biological opinion. The Service concurred with BOEM's (then the Minerals Management Service) determination that the proposed action was not likely to adversely affect the piping plover or its critical habitat, through informal consultation. Please note that piping plovers begin arriving at their wintering grounds along the gulf coast as early as mid-July. We recommend you remove sentence five from the second paragraph (*i.e.*, piping plovers do not nest in Louisiana or along the gulf coast).

FWS-37 Page 4-781: For the third paragraph, please note that up-to-date information on the Louisiana nonessential, experimental population of whooping cranes (*Grus americana*) is available at http://www.wlf.louisiana.gov/wildlife/whooping-cranes, maintained by the Louisiana Department of Wildlife and Fisheries. To date, three of the original 10 cranes released in February 2011 remain. A second cohort of 16 cranes was released at the same site on December 1, 2011. Regarding paragraph four, second sentence, please note that whooping cranes may rarely occur in Mississippi and Alabama as transient individuals only. They are not known to breed in those states. For additional information regarding whooping cranes, please contact Billy Brooks at our Ecological Services field office in Jacksonville, Florida, at 904-731-3136.

FWS-38 Page 4-782: Please revise the first sentence of paragraph two which incorrectly states that effects to the endangered whooping crane and its critical habitat from the 2007-2012 Gulf of Mexico oil and gas lease sale program were assessed in a Service biological opinion. The Service (highlighted later in the paragraph) concurred with BOEM's (then the Minerals Management Service) determination that the proposed action was not likely to adversely affect the whooping crane or its critical habitat, through informal consultation.

FWS-39 Page 4-782: Please revise the first sentence of paragraph five which incorrectly states that effects to the endangered least tern from the 2007-2012 Gulf of Mexico oil and gas lease sale program were assessed in a Service biological opinion. The Service stated that the interior least tern was not analyzed further in the informal consultation because of the species' distance from the impact area. Refer to our least tern comments for page 4-779. No determination for that species was made by BOEM (then the Minerals Management Service) and no Service concurrence was provided at that time.

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FWS-40 Page 4-783: Please revise the first sentence of paragraph three which incorrectly states that effects to the previously threatened bald eagle (*Haliaeetus leucocephalus*) from the 2007-2012 Gulf of Mexico oil and gas lease sale program were assessed in a Service biological opinion. The Service concurred with BOEM's (then the Minerals Management Service) determination that the proposed action was not likely to adversely affect the bald eagle, through informal consultation.

FWS-41 Page 4-784: Please revise the first sentence of paragraph four which incorrectly states that effects to the previously endangered brown pelican (*Pelecanus occidentalis*) from the 2007-2012 Gulf of Mexico oil and gas lease sale program were assessed in a Service biological opinion. The Service (highlighted later in the paragraph) concurred with BOEM's (then the Minerals Management Service) determination that the proposed action was not likely to adversely affect the brown pelican, through informal consultation.

FWS-42 Page 4-790: In the first sentence, please provide a citation for the reference "… (USDOI, 2009) …." It does not exist in the document.

FWS-43 Page 4-790: We recommend you clarify the relevance of using Figure 4-28, which depicts poverty rates across the gulf coast, when discussing wildlife coastal habitat impacts from petroleum development in the last paragraph. Otherwise, we suggest it be removed.

FWS-44 Page 4-792: Please remove the reference to Figure 4-25, which depicts a gas supply schematic, in the second paragraph. We do not believe that figure is relevant to the discussion of helicopter traffic.

FWS-45 Page 4-794: Please remove the reference to Figures 3-5 and 4-22, which depict coastal and onshore infrastructures, in the fourth paragraph. We do not believe those figures are relevant to the discussion of off-shore platform impacts on birds.

FWS-46 Page 4-795: Please remove the reference to Figure 4-22, which depicts onshore infrastructures (except helicopter center locations) in the first paragraph. We do not believe that figure is relevant to the discussion of helicopter operations in the WPA.

FWS-47 Page 4-798: We suggest you discuss in more detail the potential biases of the OSRA model described in the third paragraph and identify how the new OSRA spill analyses for both typical and catastrophic spills (Appendix C) address those biases.

FWS-48 Page 4-807: We recommend that the following language be inserted after the last sentence of paragraph three: "The Max Plank Institute in Europe has determined through research that it is the red component of the light that affects birds the most and it has an impact on their internal compass, causing them to fly in circles until they either collide with something or fall to the ground (or sea) exhausted. This research resulted in the development of a new lighting system which has very little red light in the spectrum and is slightly green. This new lighting system has shown a decrease in bird attraction on a North Shore platform. The new system was installed along-side the old system and when the lights were switched from the old to the new system the circling birds re-orientated

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their flight pattern and flew away from the platform. The new lighting dramatically reduced the kills at the platform. If new platforms are designed to utilize this lighting system and existing platforms convert their lights to greener lights the increase in bird collisions due to increasing production in the GOM may be mitigated."

FWS-49 Page 4-817: Please note that the westernmost boundary for gulf sturgeon critical habitat begins immediately east of the Lake Pontchartrain Causeway in Louisiana, not Lake Borgne as is described in the third paragraph, sentence five. Refer to our comments for page 2-59 and Figure 3-22 regarding the correct critical habitat boundaries.

FWS-50 Page 4-828: To clarify the ninth sentence of the second paragraph, we suggest you reword the sentence to read "… through the NRDAR process by the FWS and NMFS …." Both agencies lead a group of researchers evaluating the impacts of the DWH spill on gulf sturgeon.

FWS-51 Page 4-829: To clarify the second sentence of the second paragraph, we suggest you reword the sentence to read "… buoy systems spearheaded by the FWS and NMFS through the NRDAR process." Both agencies lead a group of researchers evaluating the impacts of the DWH spill on gulf sturgeon.

FWS-52 Page 4-968: Please add St. Tammany and Washington Parishes, Louisiana, to the range description for the threatened Louisiana quillwort (*Isoetes louisianensis*) in paragraph two. Contrary to your statement in the first sentence of paragraph three, Alabama red-belly turtles (*Pseudemys alabamensis*) do occupy broad, shallow coastal brackish marshes and bays from the Biloxi River system of Mississippi to Mobile Bay in Alabama. Known nesting sites include Gravine Island (a spoil island that occurs at the mouth of Mobile Bay) and the brackish marshes along the Highway 90 Causeway across Mobile Bay in Alabama (L. LaClaire, pers. comm.) Therefore, we recommend BOEM assess the impacts of the proposed project to the Alabama red-belly turtle in more detail. Please contact Linda LaClaire with our Ecological Services field office in Jackson, Mississippi, at 601-321-1126 for more information.

FWS-53 Figure 3-13: We recommend you reference this figure which maps the OSRA probabilities of impacting manatee habitats when discussing impacts of the proposed action to manatees. We could find no reference to this figure in the sections dedicated to manatees.

FWS-54 Table 2-2: We recommend you update the table to include all OCS blowouts through 2011 to better describe impacts from petroleum development in the OCS.

FWS-55 Tables 3-3, 3-4 and 3-6: To more fully disclose and describe pipeline impacts in the Gulf of Mexico, we recommend you provide the length of pipelines in State waters, particularly as it relates to cumulative effects of the proposed action in these tables. Otherwise, please explain why this information is not provided. Please explain why the total length of OCS pipelines is significantly greater than the total length of pipelines in waters 0-60 meters (0-197 ft) deep when the total length of pipelines in deeper waters are not available.

FWS-56 Tables 3-4 and 3-6: We recommend you update the offshore scenario information in these tables to include existing OCS development (*i.e.*, include years prior to 2012). Doing so will better quantify cumulative impacts of the proposed project.

FWS-57 Tables 4-9, 4-10 and 4-11: We suggest these tables be updated with the following information. Bald eagles are delisted and no longer protected under the Endangered Species Act (ESA). However, they are still protected under the MBTA and the BGEPA. Peregrine falcons (*Falco peregrinus*) are delisted and no longer protected under the ESA. However, they are still protected under the MBTA. Snowy plovers (*Charadrius alexandrinus tenuirostris*) and least terns (see our comments for page 4-779) that occur along the gulf coast and seaside sparrows (*Ammodramus maritima*) are not listed under the ESA, but are protected under the MBTA. However, a subspecies of the seaside sparrow, the Cape Sable seaside sparrow (*A.m. mirabilis*) is endangered and protected under the ESA. Mountain plovers (*Charadrius montanus*), red knots and Sprague's pipits (*Anthus spragueii*) are not protected under the ESA, but are candidates for listing. They are still protected under the MBTA.

FWS-58 Table 4-14: Please clarify the asterisks next to Louisiana and Florida in the cell of this table that lists the states occupied by the endangered whooping crane. No footnote exists that explains the asterisks.

Thank you for the opportunity to review the DPEIS. Please contact Rob Smith (337-291-3134) of this office if you have any questions regarding our comments.

cc: NMFS, St. Petersburg, FL
FWS (RO), Atlanta, GA (attn.: Ken Graham and Christine Willis)
FWS, Jackson, MS (attn.: Paul NeCaise)
FWS, Daphne, AL
FWS, Panama City, FL (attn.: Jon Hemming)
FWS, Jacksonville, FL (attn.: Heath Rauschenberger)
FWS, Vero Beach, FL (attn.: Victoria Foster)

Fish and Wildlife Service

FWS-1 The comment has been incorporated by adding the following text to **Chapter 3.2.1.5.5**: "For this document, the OSRA model was run for both the proposed actions (typical lease sales) and OCS Program (2012-2051) scenarios (**Table 3-1**). All environmental resources were provided to the model by March 2011, and outputs from the model were obtained in August 2011."

FWS-2 Due to their distance from the proposed actions and the little chance for impacts even in an accidental event, BOEM's subject-matter expert believes that the American crocodile, Cape Cable seaside sparrow, aboriginal prickly apple, and Cape Sable thoroughwort do not require further impact assessments. As BOEM stated in the text and as shown in **Figures 3-8 through 3-10**, the risk of impact from an OCS spill occurrence (≥1,000 bbl) resulting from either a CPA or WPA proposed action is <0.5 percent (10- and 30-day probabilities) for South Florida.

Although there is an extremely low probability of a catastrophic spill event, the impacts of such an event are generally addressed in **Appendix B**. Adverse impacts due to routine activities resulting from a CPA proposed action are possible but unlikely. Because of the greatly improved handling of waste and trash by industry and because of the annual awareness training required by the marine debris mitigations, the plastics in the ocean are decreasing and the devastating effects on offshore and coastal marine life are minimizing. The routine activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of these species or population in the GOM due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and the permitting and siting requirements.

FWS-3 Comment noted. "Significant" as used herein refers to population-level impacts. This level of intensity (see CEQ regulations at 40 CFR 1508) may be reached for some species of coastal and marine bird resources, particularly in the case of accidental or catastrophic events. In addition to the intensity of an impact, the context of an impact can be challenging to define for avian resources due to large number of avian species breeding, wintering, and migrating through the GOM region, many of which may be affected by routine activities, but the level (or intensity) of the effects is species-dependent. Evidence to date suggests that wildlife populations will suffer a greater degree of impact as the scale (spatial and temporal) of such effects increases, i.e., the pathway of effect changes in manner that results in more severe, longer-lasting, and less predictable ways and as the relative magnitude of the overall effects increases as a product of ineffective regulations or management actions (Johnson and St. Laurent, 2011, pp. 30-32). See **Tables 4-7, 4-8, and 4-13** (see superscript b), as well as **Figures 4-18 and 4-19**, for additional information on these impacts. As described in the Final Multisale EIS, routine events likely account for the direct mortality of an estimated 200,000 avian deaths/year (primarily due to collisions with platforms) across the entire platform archipelago, in addition to an unknown number of birds that likely succumb to energetic stresses associated with nocturnal circulation events and an unknown number of birds that could potentially be negatively affected by large volumes of produced waters (Fraser et al., 2006), either through direct contact or through ingestions of contaminated food resources. **Table 4-7** provides a comparison of various sources of anthropogenic avian mortality, and the present state of knowledge suggests offshore oil and gas activities represents but a small fraction. Therefore, given the above, BOEM acknowledges that there may be adverse impacts, but they would not be expected to rise to population-level impacts.

FWS-4 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-5 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-6 Comments noted. As per the reviewer's suggestion, a sentence was added to **Chapter 2** stating "[o]ne avoidance measure available is the use of lights with less red and more green in the spectrum. Such actions reduce avian nocturnal circulation (frequency and duration of events)." Please note that other Federal agencies, including USCG and the Federal Aviation Administration, have oversight over OCS structure lighting.

FWS-7 This is a map of known shoreline locations bordering the Gulf sturgeon critical habitat for the OSRA model. The OSRA model uses land (shoreline) segments to represent onshore and coastal environments (USDOI, MMS, 2007f). That is, if a land segment is considered contacted by oil, then the onshore resource adjacent to that segment is considered contacted by oil. The length of the land segments (~10 mi; 16 km) allows the critical habitat lines to go around the coast but not into inshore waters (USDOI, MMS, 2007f).

FWS-8 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-9 This recommendation has been noted; however, this EIS was meant to disclose only the WPA and CPA resource forecasts and potential impacts associated with the leasing activities. The EPA Lease Sales 225 and 226 actions and impacts are not part of the WPA and CPA proposed actions or alternatives. **Chapter 1** discloses the WPA and CPA proposed actions, proposed lease sales. **Chapter 2** discloses the WPA and CPA alternatives. **Chapters 1 and 2** have nothing to do with the EPA lease sales and potential associated actions and impacts. As stated in the text, a separate EIS will disclose and address EPA leasing activities and potential impacts. **Chapter 3** is the first place the total OCS Program's activities are discussed. The OCS Program consists of the WPA, CPA, and EPA; thus, all three planning areas are discussed in **Chapter 3.1.1.1.2**.

FWS-10 As stated in the 4th paragraph on page 3-3,

The BOEM projects that the overwhelming majority of the oil and natural gas fields discovered as a result of a WPA or CPA proposed action will reach the end of their economic life within a time span of 40 years following a lease sale. Therefore, activity levels are not projected beyond 40 years for this document. Although unusual cases exist where activity on a lease may continue beyond 40 years, our forecasts indicate that the significant activities associated with exploration, development, production, and abandonment of leases in the GOM occur well within the 40-year analysis period. For the cumulative case analysis, total OCS Program exploration and development activities are also forecast over a 40-year period. For modeling purposes and quantitative OCS Program activity analyses, a 40-year analysis period is also used. Exploration and development activity forecasts become increasingly more uncertain as the length of time of the forecast increases and the number of influencing factors increases. The forecasts used to develop the proposed actions and OCS Program scenarios are based on resource estimates developed by BOEMRE in 2011, published data and information, and historical activity and discovery trends in the GOM.

Your comment is noted; however, BOEM will continue to use a 40-year analysis period until data suggest otherwise.

FWS-11 The FWS requested that BOEM redo the decadal averages of oil spilled to demonstrate the difference between decades if the volume spilled from the *Exxon Valdez* was removed. The *Exxon Valdez* spill occurred in 1989 and spilled 261,905 bbl of oil. The volume spilled in the category "Tank Ships" in 1989 was 268,332 bbl including the *Exxon Valdez* and 6,247 bbl if the *Exxon Valdez* was omitted. Ten years of spill volumes from "Transport" (inland pipelines, tanker trucks, railroad, tank ships, and tank barges) were averaged to show the decadal average including and not including the *Exxon Valdez*. Exclusion of the *Exxon Valdez* changed the difference between decades from a 61 percent decrease to a 40 percent decrease.

FWS-12 The data on page 3-34 is presented in tabular form in **Table 3-23** ("Spill Source, Location, and Characteristics of Maximum Spill for Coastal Waters, and Offshore Waters").

FWS-13 The first two sentences in the 5th paragraph (4th complete paragraph) explain that only the State of Louisiana has experienced spills >1,000 bbl oil in coastal waters during 1996-2009 (**Table 3-23**).

FWS-14 The efficacy of utilizing 2010 barging and helicopter data was considered and was determined to still be valid as OCS production activities were not altered during neither the DWH event nor the drilling suspension. New drilling permits were affected during that time, and later, only new deepwater drilling permits were affected. Thus, it was determined that barging, which represents <1 percent of oil being transported in the 0- to 60-m (0- to 197-ft) water depth category, and helicopter operations, which would not have been impacted by area closures due to cleanup activities, would not have been dramatically altered from previous years' activities. In addition, the barging and helicopter future estimates are robust enough to account for minor increases and decreases in activity.

FWS-15 The citizens of the United States would not be well served by the efforts of two Federal agencies, BOEM and USCG, performing the duplicative job of collecting the coastal oil-spill data. Furthermore, because coastal spills are far more frequent than OCS spills, BOEM does not have the required staff to perform this function.

FWS-16 There are two primary reasons why only spills ≥1,000 bbl in size are modeled using trajectory modeling: (1) smaller spills may not persist long enough to be simulated by trajectory modeling and (2) these larger spills are likely to be identified and reported; therefore, these records are more comprehensive than those of smaller spills and less likely to result in underreported results. Both of these are identified in the Final Multisale EIS. Smaller spills, however, are still addressed in the Final Multisale EIS for each proposed action, just without the use of the trajectory modeling that BOEM believes could be misleading.

FWS-17 Fourteen years of recently reported coastal spills was used because we wanted to use the most recent data to depict the relative number of spills in each State's waters.

FWS-18 The statement on page 3-72 regarding the use of dispersants in deep water does not refer to the subsea application of dispersants. The use of subsea dispersants is discussed in **Chapter 3.2.1.9.2** under the heading "Dispersants." This chapter indicates that USEPA's most recent guidance on the topic of subsea dispersant use states that subsurface dispersants may be approved only on an incident-specific basis as requested by the USCG On-Scene Commander. In addition, both BOEM and BSEE continue to require that OCS operators show evidence that they have the ability to deploy subsea containment systems to rapidly contain a spill as a result of a loss of well control from a subsea well as required pursuant to NTL 2010-N10. These requirements for subsea containment are also discussed in **Chapter 3.2.1.9.2**.

FWS-19 The BOEM also supports measures that would reduce the chance of future spills or blowouts from occurring. However, BOEM presently does not have jurisdiction over whether an OCS operator has double ram configurations on blowout preventers and can therefore not require this. The BSEE is the Federal agency that presently has regulatory jurisdiction in this area.

FWS-20 Comment noted. The text has been edited to include mention of the draft Louisiana Coastal Master Plan and a link to the document. The comment period closed on February 25, 2012. When the Master Plan is finalized, the information will be included in future documents.

FWS-21 The text of the Final Multisale EIS has been revised to reflect the closing of the Mississippi River Gulf Outlet.

FWS-22 Comment noted. The text of the Final Multisale EIS has been revised to address this comment.

FWS-23 The text of the Final Multisale EIS has been revised to include some information on the range of the CWPPRA project's cost.

FWS-24 We believe the comment referred to page 4-450 because no reference to **Figure 4-1** was made on the cited page (i.e., page 4-436). The suggested revision has been made to the Final Multisale EIS.

FWS-25 The BOEM appreciates the additional informational websites concerning nesting beach data. Since the 2011 nesting data is still being verified, BOEM subject-matter experts have decided that the 2010 nesting data remains conservative and the better information to be included in this document.

FWS-26 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-27 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-28 Comment noted. The text of the Final Multisale EIS has been updated to reflect the comment.

FWS-29 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-30 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-31 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-32 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-33 Comments noted. Please see **Table 4-14**, which includes the red knot as a candidate species. This will be addressed in more detail in the Biological Assessment and related Section 7 Consultations with FWS.

FWS-34 Comments noted. The BOEM recognizes that the interior least tern was listed as endangered on May 28, 1985 (50 FR 21784-21792) throughout much of its breeding range in the Midwest. Similarly, ESA protection for breeding least terns only applies to certain segments or areas of Louisiana, Mississippi, and Texas inland of the coast, and ESA protections are not extended to individuals of this species nesting along the coast. The BOEM has decided to retain the least tern, piping plover, bald eagle, and eastern brown pelican in **Table 4-14**, but with inclusion of footnotes clarifying the current status (see the response to comment API 2-16). Further, BOEM recognizes that, due to the timing of the oil spill and timing of collections for this species, it is highly probable that all individuals collected were from the nonfederally listed subpopulation of least terns breeding in the Gulf of Mexico and not the federally listed Interior Population of least terns.

FWS-35 Comment noted. The language was modified to reflect the change from 37 to 18 units in Texas. This represents a reduction of 19 land units or 139,029 ac (56, 263 ha) of formerly designated critical habitat in Texas.

FWS-36 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-37 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-38 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-39 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-40 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-41 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-42 Comment noted. The citation was revised to correctly read "(USDOI, FWS and USDOI, MMS, 2009)."

FWS-43 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-44 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-45 Comment noted. The reference to these figures was deleted.

FWS-46 Comment noted. The reference to these figures was deleted.

FWS-47 Comments noted. See **Chapters 4.1.1.14 and 4.2.1.16** (five specific points to consider with respect to avian resources and OSRA); for more specific information related to OSRA, see **Chapters 3.2.1.4-3.2.1.7 and Appendix C**. The OSRA modeling takes a conservative approach and does not account for weathering processes, which are considered in other BOEM analyses (**Chapter 3.2.1.5**). With regards to weathering assumptions, consideration is given in this document to longer spill observation times (up to 30 days) for the typical OSRA runs. Beyond the estimated spills for a proposed action, which are modeled in the typical OSRA runs, analysis of a low-probability catastrophic spill has also been included in this EIS (**Appendix C**). Another point is that OSRA analyses are currently limited to surface waters. To address this, BOEM currently has an active study ("Simulation Modeling of Ocean Circulation and Oil Spills in the Gulf of Mexico," GM-11-02) to model and understand subsurface impacts from blowouts. As this work is ongoing, numerous new environmental resources were included in the typical OSRA analysis for this EIS, such as benthic polygons throughout the model domain.

FWS-48 Comments noted. Clarifying language regarding the lighting of offshore oil and gas platforms has been added. Also see the response to comment FWS-6 above.

FWS-49 The text of the Final Multisale EIS has been modified to address this concern.

FWS-50 The requested reference to the "NRDA process" was added to the text.

FWS-51 The requested reference to the "NRDA process" was added to the text.

FWS-52 Although the threatened Louisiana quillwort does occur in St. Tammany and Washington Parishes, these parishes were left out in the analyses as neither is considered a true coastal parish. Due to their reliance on terrestrial habitats to carry out their life-history functions at a considerable distance from the GOM, the activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of this species or populations in Louisiana and Mississippi.

The BOEM added text to address the comment. The greatest threats to these species remain the loss of and/or modification to suitable habitat caused by urban and agricultural development.

FWS-53 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

FWS-54 Comment noted. The table has been updated to address the comment.

FWS-55 The pipelines in State waters are not federally managed or maintained, and the length of pipeline in State waters is not known and is extremely difficult to determine. Efforts to coordinate with State agencies to quantify pipeline mileage in State waters have been underway for years, and pipeline length has not yet been determined. The BOEM will continue to work with the states to gain a better understanding of pipeline mileage in State waters.

The total length of OCS pipelines is much greater than the length of pipeline projected in 0-60 m (0-197 ft) because the total length of OCS pipelines represents pipeline mileage in all water depths. The pipeline mileage is only broken out for the 0- to 60-m (0- to 197-ft) water depth due to the fact that commercial fishing trawling activity takes place in 0- to 60-m (0- to 197-ft) water depths, and future forecasted pipeline could potentially have an impact on those activities. The future forecasted pipeline mileage in waters depths >60 m (197 ft) would not likely impacts other resources, as BOEM regulations and stipulations would ensure impacts would be reduced to those deeper water sensitive resources.

FWS-56 All OCS Program cumulative activities scenarios (i.e., **Tables 3-4, 3-15, and 3-16**) include all previous and future oil and gas activities. This means that those cumulative scenario forecasts not only include future but also existing OCS development. Your comment is noted, and the text in **Chapter 3.1.1.2** has been edited to reflect the clarification.

FWS-57 Comment noted. The tables have been revised to address the comment.

FWS-58 Comment noted. The tables have been revised to address the comment.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

February 13, 2012

Mr. Gary D. Goeke
Chief, Environmental Assessment Section
Leasing and Environment (MS 5410)
Bureau of Ocean Energy Management (BOEM)
1201 Elmwood Park Boulevard
New Orleans, LA 70133-2394

Subject: EPA NEPA Review Comments on BOEM's DEIS for "Gulf of Mexico OCS Oil and Gas Proposed Western Planning Areas Lease Sales 229, 233, 238, 246, and 248; and Proposed Central Planning Area Lease Sales 227, 231, 235, 241, and 247"; CEQ #20110434

Dear Mr. Goeke:

The U.S. Environmental Protection Agency (EPA) has reviewed the subject Bureau of Ocean Energy Management (BOEM) Draft Environmental Impact Statement (DEIS) in accordance with our responsibilities under Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. It is our understanding that BOEM proposes lease sales in the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) for lease blocks in both the Central Planning Area (CPA) and the Western Planning Area (WPA). Since the proposed action impacts areas in Region 4 and Region 6 both EPA regions participated in this review.

The EPA has participated in several recent NEPA reviews for BOEM actions, including reviews of the Draft Programmatic Environmental Impact Statement (PEIS) for the proposed 2012-2017 Outer Continental Shelf Oil and Gas Leasing Program, the Draft Supplemental Environmental Impact Statement (DSEIS) for lease sale 216/222 in the CPA of the GOM OCS Region, and the SEIS for lease sale 218 in the WPA of the GOM OCS Region.

Based on our analysis of the above referenced proposed action, EPA rates this DEIS as **"EC-2" i.e., EPA has "Environmental Concerns and Request Additional Information"** in the Final EIS (FEIS). The EPA's rating system criteria can be found online at: http://www.epa.gov/oecaerth/nepa/comments/ratings.html. Our primary concerns associated with the proposed action are related to potential impacts to air, water quality, coastal ecosystems, and EJ populations. Detailed comments are enclosed with this letter which more clearly identifies our concerns and comments. We request that a dedicated section of the FEIS include specific responses to our comments.

Lastly, since several of the mitigation strategies and lease stipulations have yet to be determined, EPA request that BOEM provide both Regions 4 and 6 the opportunity to review and comment

on future NEPA actions (including EAs and CATEXs) associated with the above referenced lease sales.

EPA appreciates the opportunity to review the DEIS. Should BOEM have questions regarding our comments, please feel free to contact Dan Holliman of my staff at 404/562-9531 or holliman.daniel@epa.gov.

Sincerely,

Heinz J. Mueller
Chief, NEPA Program Office
Office of Policy and Management

U.S. EPA DETAILED COMMENTS
ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) FOR THE U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF OCEAN ENERGY MANAGEMENT (BOEM) GULF OF MEXICO OUTER CONTINENTAL SHELF REGION WESTERN PLANNING AREAS LEASE SALES 229, 233, 238, 246, AND 248; AND PROPOSED CENTRAL PLANNING AREA LEASE SALES 227, 231, 235, 241, AND 247

BACKGROUND:
The Draft Environmental Impact Statement (DEIS) was prepared by the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM), Gulf of Mexico (GOM) Outer Continental Shelf (OCS) Region for multiple lease areas in the Central and Western Planning Areas (CPA and WPA). A total of 10 lease sales are being proposed for the CPA and WPA. EPA understands that BOEM recognizes these lease sales as major Federal actions requiring the preparation of an EIS, and that each lease sale and associated activity is very similar in nature allowing BOEM to prepare one EIS for the multiple lease sales. As described by BOEM, the need for the proposed actions (lease sales) is to further the orderly development of OCS resources.[1]

ALTERNATIVES PROPOSED:
Alternatives for Proposed WPA Lease Sales 229, 233, 238, 246, and 248
Alternative A—The Proposed Action: This alternative would offer for lease all unleased blocks within the WPA for oil and gas operations, except the following:

(1) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary; and
(2) whole and partial blocks that lie within the former Western Gap and are within 1.4 nautical miles (nmi) north of the continental shelf boundary between the U.S. and Mexico.

The WPA encompasses about 28.58 million acres (ac). As of November 2011, approximately 21.2 million ac of the WPA sale area is currently unleased. The estimated amount of natural resources projected to be developed as a result of a proposed WPA lease sale is 0.116-0.200 billion barrels of oil (BBO) and 0.538-0.938 trillion cubic feet (Tcf) of gas.

Alternative B—The Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the WPA sale area, as described for the proposed action (Alternative A), with the exception of any unleased blocks subject to the Topographic Features Stipulation.

Alternative C—No Action: This alternative is the cancellation of a proposed WPA lease sale. The opportunity for development of the estimated 0.116-0.200 BBO and 0.538-0.938 Tcf of gas that could have resulted from a proposed WPA lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would

[1] p. 1-3

be postponed. This is analyzed in the EIS for the 5-Year Program on a nationwide programmatic level.[2]

Alternatives for Proposed CPA Lease Sales 227, 231, 235, 241, and 247.
Alternative A (Preferred Alternative)—The Proposed Action: This alternative would offer for lease all unleased blocks within the CPA for oil and gas operations, with the following exceptions:

(1) blocks that were previously included within the Eastern Planning Area (EPA) and that are within 100 mi of the Florida coast;
(2) blocks east of the Military Mission line (86 degrees, 41 minutes west longitude) are not offered until 2022 as a result of the Gulf of Mexico Energy Security Act of 2006 (December 20, 2006);
(3) blocks that are beyond the U.S. Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and
(4) whole and partial blocks that lie within the former Western Gap and are within 1.4 nmi north of the continental shelf boundary between the U.S. and Mexico.

The proposed CPA lease sale area encompasses about 63 million ac of the total CPA area of 66.45 million ac. As of November 2011, about 38.6 million ac of the CPA sale area are currently unleased. The estimated amount of resources projected to be developed as a result of any one proposed CPA lease sale is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas.

Alternative B—The Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed actions, with the exception of any unleased blocks subject to the Topographic
Features Stipulation.

Alternative C—No Action: This alternative is the cancellation of one or more proposed CPA lease sales. The opportunity for development of the estimated 0.460-0.894 BBO and 1.939-3.903 Tcf of gas that could have resulted from a proposed CPA lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed. This is analyzed in the EIS for the 5-Year Program on a nationwide programmatic level.[3]

EPA COMMENTS:

USEPA-1

RANGE OF ALTERNATIVES AND SUMMARY TABLE
BOEM developed three alternatives for the two planning areas: 1) an action alternative 2) no action, and 3) the action alternative with exclusions of activities near biologically sensitive topographic features. EPA recommends that BOEM consider development of more alternatives,

[2] Cited directly from DEIS p. 2-4
[3] Cited directly from DEIS p. 2-6 – 2-7

USEPA-1

specifically, we recommend development of alternatives that combined more than one deferral area.

In addition, EPA recommends that BOEM include a summary table in the FEIS that outlines the alternatives (with preferred alternative identified). The summary table should include the potential effects from the proposed action on all resources discussed in the document. We believe that the alternatives summary table should summarize major features and significant environmental impacts of alternatives. The table could facilitate a better understanding of the alternatives, particularly distinctions between alternatives, and could provide a comparative evaluation of alternatives in a manner that sharply defines issues for the decision-maker and the public as required by NEPA.[4]

AIR

The EPA is responsible for ensuring compliance with the National Ambient Air Quality Standards (NAAQS) in the Gulf States of Texas, Louisiana, Mississippi, Alabama and Florida. In addition, EPA Region 4 is responsible for implementing and enforcing Clean Air Act (CAA) requirements for OCS sources offshore the state seaward boundaries of all areas of the Gulf of Mexico (GOM) east of 87'30" (*see* CAA section 328). Pursuant to the CAA and applicable federal regulations (see 40 CFR 55), OCS activities, such as exploratory drilling operations and production platforms are subject to the EPA requirements to obtain air quality preconstruction and operating permits. As such, the EPA will be using the DEIS prepared by BOEM for the 2012-2017 Outer Continental Shelf (OCS) Oil and Gas Central Planning Area Lease Sales as a decision making document for our required permitting actions. Based on a review of the information presented in the above referenced DEIS, we have the following comments on the air quality related analyses presented in the DEIS:

General Comments on Air Quality Impacts

USEPA-2-3

The DEIS concludes for both the CPA and WPA that "emissions of pollutants into the atmosphere from routine activities associated with a CPA/WPA action are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline," and that "regulations, monitoring, mitigation, and developing emissions related technologies would ensure these levels stay within the NAAQS."[5] EPA has reviewed the information provided in the DEIS and does not believe the analysis provides adequate information to support these broad conclusions for the following reasons:

1. No mitigation, monitoring or developing air pollution technologies are discussed in the DEIS.
2. The studies relied upon for the conclusions do not address all the pollutants and standards. In particular, the referenced studies and analyses do not evaluate or address compliance with the short term 1-hr NO_2, and SO_2 standards, nor do they address $PM_{2.5}$ NAAQS and no studies were cited that appear to include actual $PM_{2.5}$ or PM_{10} impact modeling. Hence, a conclusion cannot be reached that the project impacts are well within the NAAQS. In addition, the impacts on short-term standards cannot be evaluated by average emissions and average facility fuel use data, as provided in the referenced studies.

USEPA-4-6

3. Prevailing atmospheric conditions, emissions heights (including, short stacks on exploratory rigs), emissions rates (including concentrations of NO_x emissions from uncontrolled diesel engines that do not meet IMO & EPA Tier standards), and distance from the coastline (including lease blocks immediately adjacent to the seaward boundary) do not support the conclusions, without exception, that onshore impacts will be minimal.
4. The applicability of the DOI regulations that require monitoring and control technology evaluation, as well as BOEM evaluation and verification of air emissions and the air emissions inventory, is based on exemption thresholds that were established more than 30 years ago with less sophisticated air quality models than are currently available, and were not designed to protect the short term SO_2 and NO_2 standards, nor the $PM_{2.5}$ standards. In addition, these exemption thresholds are often 10 to 100 times greater than the thresholds applicable to sources onshore, in state tidelands, and sources east of 87.5 degrees longitude. For example, an OCS source 80 miles from shore has exempt emissions of approximately 2600 tpy of NO_x and PM under BOEM regulations. For exploratory drilling rigs, these exemption levels can be applied on a per well basis, rather than annual basis, allowing relatively high emission rates. It is not possible from the information presented to determine that such a source will not impact the NAAQS.
5. The air quality control regions to which the NAAQS apply extend to the state seaward boundaries, rather than the coastline. The proposed lease sale areas include areas immediately adjacent to the state seaward boundaries. Projected impact assessments have not been provided for these areas for all the NAAQS pollutants and standards.

EPA has the following general recommendations for the DEIS to ensure that the States, public and other stakeholders have adequate information to assess the air quality impacts of the proposed action:

USEPA-7-10

1. EPA recommends that BOEM perform air quality impact analyses for all pollutants and standards that are specific to the lease sales and include this information in an appendix for public review. In the alternative, contemporary analyses by sources that have exceeded the exemption thresholds could be relied upon for assessments and expected impacts.
2. EPA recommends that BOEM verify that the exemption threshold formula, which BOEM relies upon to require air quality modeling, is adequate to ensure compliance with the NAAQS.
3. EPA recommends that the DEIS identify monitoring requirements, potential mitigation measures, and emerging technologies and discuss how these will ensure NAAQS compliance, as indicated in the DEIS.
4. EPA recommends that the potential impacts, variable impacts, and limitations of the studies relied upon in the DEIS be factored in to the conclusions regarding air quality impacts.

[4] 40 CFR 1502.14
[5] p. 2-14 and 2-42

Specific Comments

Proposed Action (p. 1-26)

USEPA-11

- The description of the regulatory jurisdiction indicates: "*for air emissions sources located east of 87.5 W. longitude and more than 25 mi from the States' seaward boundaries, sources are subject to Federal requirements for Prevention of Significant Deterioration (PSD).*" Sources beyond 25 miles from the states' seaward boundaries are required to meet the applicable federal requirements as specified in 40 CFR 52.13, which may include requirements different than or in addition to PSD, such as the Title V operating permit program and applicable New Source Performance Standards. EPA recommends dropping the limited reference to PSD or including the other potentially applicable federal requirements.

USEPA-12

- This section describes the two-level hierarchy of evaluation criteria the BOEM uses to protect the NAAQS and indicates that the initial evaluation of worst-case emissions corresponds to the USEPA screening step, where the proposed activity emissions are checked against the screening thresholds or exemption levels. Pursuant to BOEM requirements, only sources that are above this threshold are required to perform air quality modeling, mitigate emissions and apply control technology. EPA's thresholds, however, are set by the Clean Air Act at 100 tons per year for Title V applicability and 100 to 250 tons per for PSD review. When PSD is triggered for the project, substantially lower thresholds (40 tpy of NO_x & SO_2, 10 tpy $PM_{2.5}$, 100 CO, etc.) trigger air quality modeling and BACT analysis. Sources over 250 TPY are required to apply BACT to all emissions units over these thresholds. Hence, essentially all sources are subject to control technology review. In contrast, BOEM's distance based exemption thresholds are often 2000 – 4000 tons - applied per project per pollutant, which in the case of exploratory drilling may occur over 40-90 days. This criterion allows sources with very high emissions rates to avoid assessment of onshore impacts at the project level tier, and a majority of sources are not subject to review or substantive air quality requirements. To avoid the implication that the level of review is similar, EPA recommends that the DEIS not refer to the screen step as analogous to the EPA PSD program.

USEPA-13

- In addition, this section indicates that the projected contributions to on shore pollutant concentrations are also subject to the "same limits" as the USEPA applies to onshore areas under their PSD program. EPA believes the DEIS is referring to the PSD increments, which are not analogous to limits. This statement could be interpreted to imply that emission limits are established that are equivalent to EPA's PSD emissions limits, such as BACT. EPA recommends that this be clarified to avoid confusion.

<u>Background/Introduction</u>: WPA pg. 4-11 through 4-12 and CPA pg.4- 442 through 4-443:

- "*By far, most of the documented production of sour gas (i.e., high sulfur content) lies within 150 km (93 mi) of the Breton National Wilderness Area…Flaring of gas containing H_2S (sour gas) is of concern because it could significantly impact nearby onshore areas, particularly when considering the short-duration averaging periods (1 and 24 hr) for SO_2.*"pg. 4-11. The CPA analysis on pg. 4-442 adds: *"Natural gas from the Norphlet Formation in the northeastern portion of the CPA, just south of Alabama and Mississippi, tends to range between 40 and 140 ppm on the OCS…"*

USEPA-14

These statements imply that both proposed actions may significantly contribute to SO_2 levels. The Proposed Action sections and the Cumulative Impacts sections do not explicitly characterize the levels of SO_2, hence EPA recommends the later sections should provide such analysis.

- "*To prevent inadvertently exceeding established criteria for SO_2 for the 1-hour and 24-hour averaging periods, all incinerating events involving H_2S or liquid hydrocarbons containing sulfur are reported to BSEE and are evaluated individually for compliance with safety and flaring requirements.*" WPA pg. 4-12 and CPA pg. 4-442

USEPA-15

It is not clear how the compliance with safety and flaring requirements will protect air quality standards. In particular, safety and flaring requirements have not been described; therefore EPA recommends that the DEIS describe how these requirements will prevent a violation of the SO_2 increments.

<u>Proposed Action Analysis:</u> WPA pg. 4-13 and CPA pg.4- 443

USEPA-16

- The first sentence in the WPA section references Table 4-2, found on Tables-50, in the third volume of the EIS. The corresponding CPA section references Table 4-64, found on Tables-148. Table 4-2 and 4-64 provide proposed emissions in tons per year for WPA and CPA, respectively. The tables do not clearly show how or where these numbers were generated. EPA recommends that these tables include footnotes explaining the calculations, or referencing studies that generated these numbers to provide more insight into the table's accuracy and relevance.

USEPA-17

- In addition, throughout the sections on air quality the authors state the NAAQS increments will not be consumed. However, aside from ozone, no explicit modeling results are provided. Therefore, these conclusions appear unsubstantiated. EPA recommends that a table comparing the estimated concentration generated from the proposed WPA and CPA in ug/m^3 to the NAAQS would provide documentation supporting the conclusions that the projects will not interfere with attainment of the NAAQS.

- "*The BSEE regulations (30 CFR 250.303) establish 1-hour and 8-hour significance levels for CO. A comparison of the projected emission rate to the BSEE exemption level would be used to assess CO impacts. The formula to compute the emission rate in tons/yr for CO is $3{,}400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility.*"

USEPA-18

This paragraph alone does not provide enough information. This might preface a CO modeling analysis, but none follows. The significance levels mentioned in the first half apply to an area, while the formula is for a specific source. EPA suggests that a modeling analysis would need to use background and meteorological data in addition to the referenced formula to determine whether the project would exceed the CO significance level.

WPA pg. 4-14 and CPA pg.4-444

- *"Since future air emission from all sources in the area are expected to be about the same level or less, it is expected that the impact on visibility due to the presence of fine particulates would be minor."*

USEPA-19

The DEIS does not provide adequate documentation to support the premise that air emissions from all sources in the area are expected to be about the same or less. For example, activities in the central GOM have increased as more area has opened for drilling.

WPA pg. 4-14 <u>Summary and Conclusion</u>:

- *"The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas."*

USEPA-20

None of the sections preceding this summary discuss a modeling analysis for PM_{10} and SO_x. Perhaps the modeling analysis was inadvertently removed. Page 4-13 has a detailed discussion of ozone only. EPA recommends that this statement be clarified.

WPA pg.4-14 through 4-16 and CPA pg. 4-445 through 4-448 <u>Impacts of Accidental Events</u>:

- *"The VOC emissions from the evaporation of spilled oil can contribute to the formation of particulate matter ($PM_{2.5}$). In-situ burning also generates particulate matter. Particulate matter can cause adverse human respiratory effects and can also result in a reduction of atmospheric visibility or haze."* pg.4-15. Corresponding in the CPA section, *"In-situ burning also generates particulate matter…The $PM_{2.5}$ concentrations in a plume could have the potential to temporarily degrade visibility in any affected PSD Class I areas (i.e., National Wilderness Areas and National Parks) such as the Breton National Wilderness Area in the CPA and other areas where visibility is important."* pg. 4-445. Also, *"Particulate matter from the flare would also affect visibility."* WPA pg. 4-16, and the CPA section continues with, *"Flaring or burning activities upwind of a PSD Class I area, e.g., the Breton National Wilderness Area in the CPA, could adversely affect air quality through increased SO_2 concentrations and reduced visibility." pg. 4-447.*

USEPA-21

These statements imply that an accidental event will adversely impact visibility. However, the conclusion states that, *"Other emissions of pollutants into the atmosphere from accidental events as a result of a WPA proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications."* WPA pg. 4-16 corresponding CPA pg. 4-447. EPA suggests that as written, the conclusion does not reflect the

USEPA-21

content of the section. If the DEIS provided a numerical analysis of visibility, then a definitive inference might emerge with more clarity.

Cumulative Impacts and Summary Conclusion: WPA pg.4-17 through 4-19 & CPA pg. 4-448 through 4-449

USEPA-22

- *"In a MMS study, the modeling results indicate that the cumulative impacts are well within the PSD Class I allowable increment (Wheeler et al., 2008)."* WPA pg. 4-17 and CPA 4-448. This study is also cited on page 4-441 to show that the Class I increment for BNWA has not been consumed. Given the year of the study, it would not incorporate recently permitted sources, nor include emissions from sources located within the lease blocks covered in this DEIS, several of which are previously undeveloped areas located near Breton National Wilderness area. In addition, the analysis is reported to include only platforms and not exploratory operations. Hence, the EPA does not believe that it can be determined at this stage that impacts are "well within PSD increments" without more detailed analysis.

USEPA-23

- *"Modeling tools for the transport and dispersion of air pollutants such as ozone, carbon monoxide, nitrogen dioxide, and PAH's are required to determine the fate and pollutant concentrations in the environment and subsequently for the assessment of the environmental impacts. It appears that these tools are currently not available for the application to the offshore environment, which is needed to be developed especially for the long-range transport of air pollutants."* While EPA concurs with the assessment that modeling is required to determine and assess the impacts of air emissions, EPA does not concur that such tools are currently not available for the offshore environment. Numerous air quality impact assessments have been performed for offshore projects, including PSD and NEPA impact analyses in the GOM for OCS and LNG projects, as well as projects offshore Alaska, California and Massachusetts.

CPA Section 4.2.1.1: pg.4- 442 <u>Impacts of Routine Events</u>

USEPA-24

- *"During exploratory drilling operations, air emissions may be high enough to contribute to exceedances of the new short-term, 1-hour NO_x and SO_x NAAQS and, hence, may affect the onshore air quality."* This statement appears to directly contradict the conclusions in the executive summary and summary sections that emissions are expected to be well within the NAAQS. EPA recommends that the conclusions be revised to reflect these potential impacts.

<u>Compliance with Coastal Zone Management Act</u>

USEPA-25

- The BOEM provides the State air pollution control agencies a table of projected emissions data in tons per project. However, impacts to the NAAQS cannot be assessed without impact modeling. It is not realistic to assume that States have the source specific data or resources to conduct project specific modeling for OCS drilling and production projects to determine coastal consistency. EPA is concerned that without source specific modeling performed by the applicants using refined data, adjacent states will not have the necessary information to ensure compliance with the NAAQS and CZMA, especially for the new lease areas adjacent to the state seaward boundaries. EPA requests that the DEIS address how analyses will be conducted to ensure compliance with the CZMA.

Description of Affected Environment

USEPA-26

- The DEIS accurately indicates that EPA has recently adopted several revised NAAQS, including short term 1-hr standards for nitrogen dioxide and sulfur dioxide and a revised 8-hours ozone standard. In several sections, the DEIS indicates that these standards have been "*fully implemented.*" While EPA has promulgated these standards, they have not been fully implemented by EPA and the States. EPA is concerned that the choice of the term "fully implemented" implies air quality protections are currently in place. However, the non-attainment areas have not yet been designated under these standards nor have states been required to revise their State Implementation Plans to implement the new standards. EPA recommends these references be revised to indicate that the standards have been "promulgated."

WATER QUALITY / NPDES

EPA regulates discharges associated with offshore oil and gas exploration, development, and production on OCS under the Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) permit program. Section 403 of the CWA requires that NPDES permits for discharges into territorial seas, the contiguous zone, and the oceans be issued in compliance with EPA's guidelines for determining the degradation of marine waters.

USEPA-27

EPA recommends the insertion of the following language into the FEIS with regards to NPDES:

Permits issued under Section 402 0f the Clean Water Act for offshore activities must comply with any applicable water quality standards and/or federal water quality criteria as well as Section 403 of the Clean Water Act. Water Quality Standards consist of the water body's designated uses, water quality criteria to protect those uses and determine if they are being attained, and antidegredation policies to help protect high quality water bodies. Discharges from offshore activities near state water boundaries must comply with all applicable State Water Quality Standards.

Section 403 of the Clean Water Act requires that NPDES permits for discharges to the territorial seas (baseline to three miles), the contiguous zone, and the ocean be issued in compliance with EPA's regulations for preventing unreasonable degradation of the receiving waters. Prior to permit issuance, ocean discharges must be evaluated against EPA's published criteria for determination of unreasonable degradation. Unreasonable degradation is defined in the NPDES regulations (40 CFR 125.121[e]) as the following.

1. *Significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities.*
2. *Threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms.*
3. *Loss of aesthetic, recreational, scientific or economic values, which is unreasonable in relation to the benefit derived from the discharge.*

In addition, there are two primary federal environmental statutes governing dredged material disposal. The Marine Protection, Research, and Sanctuaries Act (MPRSA, also called the Ocean Dumping Act) governs transportation for the purpose of disposal into ocean waters. The Clean Water Act (CWA) Section 404 governs discharge of dredged or fill material into U.S. coastal and inland waters. EPA and the U.S. Army Corps of Engineers share responsibility for regulation of dredged material. EPA and the Corps are jointly responsible for management and monitoring of ocean disposal sites.

USEPA-28

- The Corps issues permits under the CWA and MPRSA.
- EPA has the lead for establishing environmental guidelines/criteria that must be met to receive a permit under either statute.
- Permits for ocean dumping of dredged material are subject to EPA review and concurrence. CWA permits for dredged material discharge are subject to EPA review and veto, if EPA's environmental guidelines are not met.
- EPA is responsible for identifying recommended ocean disposal sites.

EPA recommends that this additional information regarding disposal of material into ocean waters be added to the FEIS.

WETLANDS AND COASTAL AREAS

USEPA-29

Impacts to Coastal Areas: It is stated in the DEIS that: "Impacts from these operations are minimal due to requirements for the beneficial use of the dredged material for wetland and beach construction and restoration."[6] Beneficial use of dredged material is a commendable goal and we fully support increasing the amount of dredged material used beneficially for purposes of habitat restoration or enhancement. However, beneficial use is not a requirement and it is not a required form of mitigation. The goal should certainly be to minimize impacts and beneficial use is a recommended option for minimizing impacts. However, it cannot be assumed that the dredged material management plan for any particular dredging event will necessarily involve beneficial use or that the impacts from dredging will routinely be considered to be minimal, without a defined mitigation plan. A more accurate statement related to this situation is found in the next paragraph: "Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas."[7]

USEPA-30

Primary Impacts of Oil Spills:[8] In order to present a more complete picture of the wetland impacts from the Deepwater Horizon oil spill, this section could include not only a discussion of the amount and type of oil affecting plants but also the different recovery scenarios between wetland plants that were oiled once versus those that were oiled repetitively during the course of the spill.

USEPA-31

Coastal Restoration Programs:[9] The discussion about the Louisiana State Master Plan should not stop with the development of the 2007 plan. The updated draft 2012 Coastal Master Plan builds upon the earlier plan by proposing new modeling techniques and planning scenarios to

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[6] p. 2-16
[7] p. 2-44- Coastal Barrier Beaches and Associated Dunes Discussion
[8] p. 4-509
[9] p. 3-102

USEPA-31

select from 145 of the projects deemed to be the highest performing options. Land loss rates and restoration costs are updated and geographic priorities for protection are included. In this same section, the discussion of net land gain expected over the next 40 years includes an assumption that 179 CWPPRA projects will be completed by the end of the program authorization period in 2019. This conclusion should be qualified by an explanation that, while the program is authorized through 2019, Congress has postponed renewing the CWPPRA funding source and it is currently being sustained by Congressional continuing resolution. Under the current situation, CWPPRA funding for new construction projects is only expected to be available for an additional two to three years.

SPILL RESPONSE

USEPA-32

Onshore Response and Cleanup:[10] It would be appropriate to include in this section the conclusions regarding the use of sand barrier berms as an oil spill response strategy found in the BOEM FSEIS for OCS Central Planning Area Lease Sales 216 & 222: "Given that current data indicate that the emergency berms in Louisiana were not effective in minimizing impacts from the DWH event and that the Presidential Oil Spill Commission counseled against future use of such berms (Oil Spill Commission, 2011a), BOEM does not expect that similar berms would be used as a response measure if a low-probability catastrophic event were to occur in the future."

USEPA-33

Spill Response Activities:[11] This section should include a discussion of the impacts to sea turtles from the dredging operations associated with the construction of the barrier berms to the east and west of the mouth of the Mississippi River during the Deepwater Horizon (DWH) response efforts. This response activity resulted in the potential for exceeding both the lethal and nonlethal sea turtle "takes" for the New Orleans District of the Corps. Also of note, the sizes and age classes of the turtles killed or entrained at that time of year were unexpected for the areas where the dredging occurred.

USEPA-34

Deepwater Response Capabilities: EPA continues to be concerned about response capabilities during catastrophic events such as the DWH. As new technologies and Best Management Practices (BMPs) to respond to deepwater spills are developed as a result of the DWH event, we encourage BOEM to discuss these in future NEPA documents and adopt as necessary to ensure adequate response capabilities for these types of events.

GOM HYPOXIA ZONE

USEPA-35

EPA recommends that the discussion of the Gulf hypoxic zone off the Mississippi River[12] be updated. The areal extent of the Gulf of Mexico hypoxic zone for the summer of 2011 was estimated by the Louisiana Universities Marine Consortium (LUMCON) as covering 6,765 square miles. Record spring flooding of the Mississippi River was expected to result in one of the largest recorded occurrences but an average sized zone was evident following strong winds and waves associated with Tropical Storm Don.

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[10] Section 3.2.1.9.4
[11] p. 4-237
[12] p. 4-462

ENVIRONMENTAL JUSTICE AND SUBSISTENCE FISHING

EPA appreciates BOEM's efforts to address Environmental Justice (EJ) in Chapter 4. The EJ discussions focused on state and county demographics, employment, income, minority populations, and poverty rates. Since the DEIS is addressing actions that cover such a large area, it is difficult to identify direct impacts on EJ communities.

USEPA-36

It is stated in the DEIS that: "Environmental justice implications arise indirectly from onshore activities conducted in support of OCS exploration, development, and production. Because the onshore infrastructure support system for OCS-related industry (and its associated labor force) is highly developed, widespread, and has operated for decades within a heterogeneous Gulf of Mexico population, the proposed actions are not expected to have disproportionately high or adverse environmental or health effects on minority or low-income people. The proposed actions would help to maintain ongoing levels of activity rather than expand them."[13] Although, we do not dispute that EJ communities in these coastal areas will feel indirect impacts from the purposed action, EPA is unclear of the overall purpose of this statement. One would assume there would be expansion of the existing infrastructure to accommodate drilling activities for these new lease areas, therefore there is a potential for additional impacts to be felt by the EJ community. EPA does however understand that EJ communities will not only see impacts but also benefits through job creation and increased economic activities in these areas. We recommend that BOEM more specifically address these impacts and benefits if possible in the FEIS and future NEPA associate with the proposed action.

If a catastrophic spill occurred in the WPA or CPA similar to the DWH event, GOM coastal residents would feel the impact, regardless of income or social status. BOEM does acknowledge that in an event similar to DWH, low-income and minority populations (EJ populations) would be impacted more severely than middle and upper-class populations. Moreover, because of the way of life in these coastal areas, much of the populations in these areas rely on subsistence fishing and hunting and therefore maybe less able to adapt during events such as the DWH spill.

USEPA-37

It is stated in the DEIS that "Besides their economic reliance on commercial fishing and oystering, low-income and minority groups along the coast rely heavily on these fisheries and on other traditional subsistence fishing, hunting, trapping, and gathering activities to augment their diets and household incomes (e.g., see Hemmerling and Colten, 2003, for an evaluation of environmental justice considerations for south Lafourche Parish)."[14] EPA is concerned that the importance of subsistence fishing in these regions is not fully understood and that better quantification of these types of potential impacts from catastrophic spills on coastal populations (including EJ populations) is needed. EPA is encouraged that BOEM is currently funding a subsistence study of the Gulf Coast to better document subsistence distribution networks[15] and encourages BOEM to include the results of this study in the FEIS if available.

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[13] p. summary section - xv
[14] P. 4-414
[15] P. 4-421

USEPA-38

MITIGATION
The DEIS states that "Application of lease stipulations will be considered by the Assistant Secretary of the Interior for Land and Minerals (ASLM). The inclusion of the stipulations as part of the analysis of the proposed action does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from a proposed lease sale, nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions warrant. Any stipulations or mitigation requirements to be included in a lease sale will be described in the Final Notice of Sale. Mitigation measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease."[16] EPA remains somewhat unclear on why mitigation stipulations are not specified for the preferred alternative, but are listed as mitigation strategies for the proposed action. EPA recommends that these stipulations be included in the proposed alternative allowing the public to adequately evaluate the proposed action and the proposed mitigation for that action. Alternatively, BOEM could provide additional information in the FEIS describing the process by which the ASLM adopts these mitigation stipulations for proposed lease sales and how and when the public would be able to provide comments on these stipulations added to the lease.

EDITORIAL COMMENTS

USEPA-39

Page 1-5, Section 1.3, Table - Revisions should be made to the two citations for the Clean Water Act. The citation for the Clean Water Act should be listed as 33 USC 1251 *et seq*. The citation for the National Pollutant Discharge Elimination System is not Section 316(b), as listed, but is Section 402. Section 316(b) of the Clean Water Act relates to cooling water discharges, which might also be applicable to the proposed action. Other sections of the Clean Water Act may also apply to the proposed action. Therefore, it would be reasonable to list the correct citation for the Clean Water Act and, rather than correcting the citation for the NPDES program, delete that reference and let the reference to the entire Act stand alone. Likewise, the National Estuary Program would probably best be cited in this table as Clean Water Act Section 320 or P.L. 100-4, not as P.L. 104-4.

USEPA-40

Page 3-99, Section 3.3.4.3, Maintenance Dredging and Federal Channels: This section should be corrected. The Mississippi River Gulf Outlet, although a former federally maintained navigation channel, was de-authorized by the U.S. Army Corps of Engineers in 2009 and is no longer a maintained navigation channel. Therefore, it should be deleted from the list of federal channels in Louisiana and should not be factored into the calculation for the combined length of federal channels.

USEPA-41

Figure 3-5 – Hard to see OCS pipelines and other infrastructure depicted in figure. Recommend larger map with clearer depiction of pipelines and infrastructure.

USEPA-42

Figure 3-29 and 3-30 – These figures are hard to interpret due to the legend being located in the middle of the map. Recommend shifting legend to one side of the map. Also, it is noted that significantly more spills are located in the CPA vs WPA. Recommend some text below figures explaining the reasoning for this difference.

[16] p. Summary Section - ix

USEPA-43

Table 3-7 – Recommend adding text below table explaining the increase deepwater drilling trend depicted in table. This is already described in the text.

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U.S. Environmental Protection Agency

USEPA-1 The alternatives for this Multisale EIS are those available within the framework of the Five-Year Program. NEPA does require an analysis of alternatives, but it does not require carrying all alternatives considered through a full analysis of the impacts of each alternative. In the Draft Multisale EIS, BOEM considered the alternative of limiting leasing to shallow waters but came to the conclusion that this alternative did not meet the purpose and need. This Multisale EIS meets the requirements of NEPA in the development and consideration of alternatives.

The structure of this Multisale EIS was prepared to present the proposed action, alternatives, and impact assessment in a clear comparative form and to provide decisionmakers a clear choice among options. The proposed actions are a lease sale in each planning area, and the action alternatives are limited to a reduction in the scope of leases offered. The BOEM feels that issues are clearly defined and that information to determine a reasoned choice among the alternatives is clear. The BOEM also feels that reducing these impacts to a table would be potentially more confusing and repetitive.

USEPA-2 Mitigations are discussed in **Chapter 2.2.2.2**. The BOEM requires that all OCS technologies and operations use the best available and safety technology. These standards include pollution control equipment (see **Chapter 1.5**, "Best Available and Safety Control Technologies"). As stated in **Chapter 2.2.2.2**, mitigating measures are a standard part of BOEM's program to ensure that the operations are always conducted in an environmentally sound manner. There are currently over 120 standard mitigations. The mitigations are applied during the postlease plans approval process. Air mitigations include documentation of fuel use or run time, verifications of emissions, monitoring of SO_x emissions (sulfur recovery unit), monitoring of NO_x emissions (catalytic converter), and restrictions on flaring.

Industry is required to participate in the Gulfwide Offshore Activities Data System (GOADS) study every 3 years. Although this action is not air monitoring, it captures the level of activity from combustion sources and from fugitive emissions, which is translated into emissions. These data are available for a variety of modeling efforts.

The BSEE regulations provide for some limited volume, short duration flaring, or venting of oil and natural gas upon approval by BSEE. The BSEE and BOEM issued a final rule (30 CFR 250.490 and 30 CFR 550.215, respectively [*Federal Register*, 2011a]) governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulfur dioxide, protecting personnel, providing warning systems and signage, and establishing requirements for hydrogen sulfide flaring and venting.

USEPA-3 The BOEM agrees with USEPA that the referenced studies do not include the 1-hour NO_2 and SO_2 standards. The referenced studies and analysis do not address compliance with the short term 1-hour NO_2 standard announced on January 22, 2010, or 1-hour SO_x standard announced on June 2, 2010. The BOEM subject-matter experts did not identify studies relevant to the proposed action and alternatives that included these new standards.

At this time, BOEM addresses this gap during the postlease plans approval process. For the postlease process, operators submit their projected maximum emissions in order to obtain plans approval. The projected emissions are compared with exemption thresholds. If the emissions exceed the exemption thresholds, OCD (Offshore and Coastal Dispersion) modeling is performed. The OCD modeling results provides annual and 1-hour NO_2 receptor concentrations. The results are compared with the 1-hour NO_2 interim, significant impact level (SIL) (USEPA, 2010e). The primary purpose of the SIL is to serve as a screening tool to identify a level of ambient impact that is sufficiently low relative to the NAAQS such that the impact can be considered *de minimus*. The SO_x emissions rarely exceed exemption thresholds so this adaptation has not been applied to 1-hour SO_x levels. The USEPA is correct that impacts on short-term standards cannot be evaluated by average emissions and average facility fuel use data.

The BOEM acknowledges that this information remains incomplete and unavailable at this time and may be relevant to reasonably foreseeable significant impacts. The BOEM continues to look into options for addressing this gap in information, including potential regulations, modeling, and new studies; but, regardless of the cost, these options are not available or likely to result in new information within the timeline of this EIS. As noted above and in **Chapters 4.1 and 4.2**, BOEM subject-matter experts have applied what scientifically credible information is available using accepted methodologies and has tried to conservatively overestimate potential emissions and impacts where prudent. Given the long history of the OCS oil and gas program, and the distance from shore of these activities from most onshore receptors, BOEM does not believe that this incomplete or unavailable information is likely to be essential to a reasoned choice among alternatives, including the No Action alternative.

USEPA-4 Comment noted. Please see the response to comment USEPA-3. There are many characteristics of the offshore meteorology and emissions sources that differ from onshore meteorology and sources. Consideration of these distinctions were taken into account in BOEM's conclusion that onshore impacts are expected to be minimal; any exception to this would still not be expected to rise to a level of significance over the long term.

USEPA-5 Comment noted. Please see the response to comment USEPA-3. The BOEM regulations address the NAAQS differently than USEPA. Given changes in the NAAQS and current incomplete and unavailable information, BOEM continues to evaluate options, including the potential for updated regulations. In the interim, BOEM has considered the available information and believes, on the whole, that it is unlikely that OCS activities relating to the proposed actions would result in significant onshore impacts.

USEPA-6 Comment noted. For such situations where impact assessments have not been performed, such as operations adjacent to the State seaward boundary, BOEM has relied on conservative assumptions made in the postlease approval process, such as the submittal of maximum potential emissions to protect air quality and the use of the exemption threshold formula. See also the response to comment USEPA-3.

USEPA-7 Please see the response to comment USEPA-3 on incomplete and unavailable information. The BOEM, however, has received a number of OCD modeling submittals in the past year for 1-hour NO_2 and annual SO_2 emissions. The emissions did not exceed the 1-hour NO_2 or annual SO_2 standard.

The OCD modeling was also performed for the 2007-2012 Multisale EIS (Tables 4-18, 4-19, 4-26, and 4-27 in USDOI, MMS, 2007c). The modeling was performed prior to the addition of the 1-hour NO_x and SO_x to the NAAQS; nevertheless, based on the similarities in impact-producing scenarios in the 2007-2012 and 2012-2017 Multisale EIS's, BOEM believes the data remain accurate and conservative.

The BOEM conducted a preliminary impact assessment of ozone on the onshore air quality for the eastern Gulf Coast (Louisiana to Florida) using the UAM-V5 and the 2000 Gulfwide emissions inventory (Haney et al., 2004). The BOEM believes that the information remains conservative and applicable to its analyses and conclusions.

USEPA-8 Please see the response to comment USEPA-3 on incomplete and unavailable information. The BOEM is considering a study to examine BOEM's exemption thresholds in light of the new short-term NO_x and SO_x standards. The commencement of this study, and any relevant results, are not expected within the timeline of the EIS, regardless of cost. After the study is completed, any necessary regulatory changes and the development of a new exemption threshold or modeling process will take additional time. As such, BOEM subject-matter experts have applied what information is available and continues to believe that the available information, on the whole, suggests that offshore activities associated with the proposed actions are unlikely to result in significant impacts.

USEPA-9 Comment noted. See the response to comment USEPA-1.

USEPA-10 The BOEM agrees to factor the limitations of the studies into the conclusions regarding air quality impacts.

USEPA-11 Conforming language was inserted in **Chapter 1.5** to address this request.

USEPA-12 Conforming language was inserted in **Chapter 1.5** to address this request.

USEPA-13 Conforming language was inserted in **Chapter 1.5** to address this request.

USEPA-14 The BOEM's analysis conservatively acknowledges that there is the potential for impacts from H_2S flaring and that such risks are not regionally uniform. Nevertheless, BOEM and BSEE have regulations and procedures in place to discourage or prohibit the routine use of flaring and procedures to minimize or reduce the impacts of emergency flaring. For example, BSEE and BOEM issued a final rule (30 CFR 250.490 and 30 CFR 550.215, respectively [*Federal Register*, 2011a]) governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulfur dioxide, protecting personnel, providing warning systems and signage, and establishing requirements for hydrogen sulfide flaring and venting. Applying these and other limitations on flaring reduce the risk of significant impacts on SO_x levels, but BOEM is conservatively acknowledging that they remain possible to the decisionmaker and the public in their evaluation of the proposed actions and alternatives.

USEPA-15 See the response to comment USEPA-14. Conforming language was added to the Final Multisale EIS.

USEPA-16 Explanatory information on how these numbers were generated has been added to **Tables 4-2 and 4-64.**

USEPA-17 Available information on the remaining increments has been added to the Final Multisale EIS.

USEPA-18 During all relevant previous studies, CO has never exceeded BOEM's exemption levels. This pollutant is not a concern in the offshore oil and gas industry, as most typical OCS-related activities do not generate significant levels of CO. Therefore, the modeling analysis is not required.

USEPA-19 Since the foreseeable air emissions from all OCS sources in the planning area are expected to be about the same or less (as compared with those of the 2007-2012 Multisale EIS based on the similarities between the 2007-2012 and 2012-2017 Multisale EIS development scenarios described in **Chapter 3**), it is expected that the impact on visibility due to the presence of fine particulates would be minor due in part to the distance of most OCS activities from shore.

The BOEM has revised the text to indicate that more area on the eastern side of the CPA has been opened for exploration and productions. However, as a result of the suspension imposed by the Gulf of Mexico Energy Security Act (GOMESA), most of the increasing activities opened for drilling in the CPA take place in the deep water, which is at a distance far from shore and therefore less likely to result in significant onshore impacts.

USEPA-20 Comment noted. Please see the response to comment USEPA-3. The "Summary and Conclusion" section has been edited to refer to the tables and modeling results in the 2007-2012 Multisale EIS, which have been incorporated by reference and which remain relevant to this EIS analysis.

USEPA-21 For most accidental events, which would likely be far from shore and relatively small in size, visibility is unlikely to be affected onshore due to distance and the likely weathering and change in composition as it reached shore. Any effects would likely be temporary and rapidly disperse once the spill is stopped. Literature and data available since the DWH event indicate that, even in a catastrophic event, visibility is unlikely to be significantly impacted and will likewise be temporary. Numerical modeling and the analysis of visibility was not conducted for the Draft Multisale EIS. This assumption was made based on DWH literature. The text has been revised for clarification.

USEPA-22 Comment noted. The BOEM has had conversations with FWS about the inclusion of temporary sources such as exploratory operations in the determination of impacts to the Class 1 area, including the increment. The paragraph preceding the 2008 citation has been edited to clarify that, because of the relatively stable level of OCS activities (see, for example, **Tables 3-2 and 3-3**), the older studies are believed to adequately reflect current OCS activities and conditions.

USEPA-23 Clarifying language has been added to the Final Multisale EIS.

USEPA-24 Please see the response to comment USEPA-3.

USEPA-25 The postlease stage is the first point at which BOEM and the applicant have sufficient source-specific data to determine if an emissions exemption threshold level would potentially be exceeded. For activities that may exceed the exemption threshold, modeling is then performed to determine if significance levels are exceeded. If the significance level is exceeded, best available control technology must be applied. Conforming language has been added to the Final Multisale EIS to clarify this process.

USEPA-26 The BOEM concurs. Clarifying language has been added to the Final Multisale EIS.

USEPA-27 The BOEM has included the recommended text.

USEPA-28 Comment noted. The recommended change was made to the text.

USEPA-29 Comment noted. The recommended change was made to the text.

USEPA-30 While this is a great idea for a study and would produce valuable information, these data are not presently available.

USEPA-31 Comment noted. The text has been edited to include mention of the draft Louisiana Coastal Master Plan and a link has been added to the document. The comment period closed on February 25, 2012. When the report is finalized, the information will be included in future documents.

USEPA-32 While it is likely that the use of sand barrier berms would not be a recommended oil-spill-response strategy during future spill events, BOEM will wait to make the determination regarding whether or not to add this information to this section until after a recommendation regarding the future use of this technology is adopted by the appropriate area and regional response plans.

USEPA-33 The NMFS has collected a number of sea turtles both before and after the DWH event, but to date, they have not provided a suspected cause of death for many or all of them. As such, there is no publicly available information to date from the U.S. Army, Corps of Engineers on whether or not the emergency berms impacted sea turtles. Given that current data indicate that the emergency berms in Louisiana were not effective in minimizing impacts from the DWH event and that the Presidential Oil Spill Commission counseled against future use of such berms (Oil Spill Commission, 2011b), BOEM does not expect that similar berms would be used as a response measure if a low-probability catastrophic event were to occur in the future.

Over the last 2 years, NOAA has documented increased numbers of sea turtle strandings in the northern GOM. Many of the stranded turtles were reported from Mississippi and Alabama waters, and very few showed signs of external oiling from the DWH event. Necropsy results from many of the stranded turtles indicate mortality due to forced submergence, which is commonly associated with fishery interactions. In June 2011, NMFS announced that it will begin scoping for the preparation of a draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (76 FR 37050).

The BOEM has added the submergence information to the Final Multisale EIS.

USEPA-34 The BOEM plans to continue to discuss best management practices and new spill-response technology in future EIS's. However, the regulatory authority for spill-response planning now resides with BSEE and not BOEM. When provided an opportunity, BOEM will work cooperatively with BSSE to provide input regarding future oil-spill-response technology and equipment requirements.

USEPA-35 The reference to the 2011 hypoxic zone has been added to the Final Multisale EIS.

USEPA-36 Comment noted. Please refer to **Chapters 4.1.1.20.1 and 4.2.1.23.1** for a discussion of the expected impacts of the WPA and CPA proposed actions on infrastructure, which would likely be maintained rather than significantly expanded. Regarding environmental justice concerns on this issue, the text of the Final Multisale EIS has been revised where appropriate.

USEPA-37 Comment noted. Currently, we do not have any interim results from the ongoing subsistence study and results will not be available within the timeframe of this EIS. As such, BOEM has conservatively assumed that subsistence fishing and fish consumption remain potential pathways for impacts to the local population. The text has been revised for clarity on subsistence.

USEPA-38 The BOEM's consideration of appropriate mitigations and stipulations are already included for each action alternative as part of the OCSLA lease sale process. An EIS is a disclosure document and, based upon its findings, is often used in the development of mitigations and stipulations to reduce or eliminate impacts of the chosen action alternative. Consistent with this principle, BOEM considers mitigations and stipulations to minimize the impacts of oil and gas exploration and development and to improve safety throughout the leasing process. The ASLM, through authority delegated by the Secretary of the Interior, may apply a number of lease sale mitigations and stipulations. **Chapter 2.2.2** discusses mitigations in the WPA and CPA. **Chapter 2.3.1.3** discusses specific mitigations and stipulations in the WPA, including the Topographic Features Stipulation, Military Areas Stipulation, Protected Species Stipulation, Law of the Sea Convention Royalty Payment Stipulation, and Transboundary Stipulation. **Chapter 2.4.1.3** discusses specific mitigations and stipulations in the CPA, including the Topographic Features Stipulation; Live Bottom Stipulation; Military Areas Stipulation; Evacuation Stipulation; Coordination Stipulation; Blocks South of Baldwin County, Alabama, Stipulation; Protected Species Stipulation; Law of the Sea Convention Royalty Payment Stipulation; Below Seabed Operations Stipulation; and Transboundary Stipulation. Additionally, a number of site-specific mitigations for environmental protection and safety are routinely applied at the postlease stage. All exploration plans, development plans, and pipeline applications are thoroughly reviewed to determine what additional protective measure(s) should to be included as a condition of plan or permit approval. Mitigations and stipulations are developed as conditions warrant and are subject to a review and approval process.

USEPA-39 Comment noted. The suggested revisions have been made to the Final Multisale EIS.

USEPA-40 The text of the Final Multisale EIS has been revised to reflect the closing of the Mississippi River Gulf Outlet.

USEPA-41 Comment noted. We think the existing figure shows the infrastructure in sufficient detail to provide a generalized picture of where the infrastructure is located, as intended.

USEPA-42 Comment noted. The figures have been revised for the Final Multisale EIS. However, we have kept the format of not including text, other than titles and sources, with the figures.

USEPA-43 Comment noted. We have kept the format of not including text, other than titles and sources, with the figures.

LANCE R. LEFLEUR
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ROBERT J. BENTLEY
GOVERNOR

February 10, 2012

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Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

RE: Gulf of Mexico OCS Oil & Gas Lease Sales 2012-2017
Draft Environmental Impact Statement
ADEM Tracking Code: 2012-080-BOEMRE

Dear Mr. Goeke:

The Alabama Department of Environmental Management has completed its review of the Bureau of Ocean Energy Management's (BOEM) Draft EIS for the proposed 5-year lease sale (2012-2017) for Outer Continental Shelf (OCS) activity in the Gulf of Mexico. This five year plan includes Western Planning Area Sales 229, 233, 238, 246, and 248 and Central Planning Area Sales 227, 231, 235, 241, and 247.

ADEM-1

The ADEM continues to recognize that Alabama Governors have consistently opposed leases within 15 miles of the Baldwin County, Alabama Coast. The ADEM supports the leasing of any unleased blocks in the Central Planning Area and Western Planning Area but does not support leasing of any blocks within 15 miles of the Baldwin County, Alabama coast. Additionally, the ADEM requests that BOEM require lease holders provide adequate protection for live bottom areas, pinnacle reefs, chemosynthetic communities, and other sensitive environments while conducting activities in the OCS off Alabama's coast.

Call or write Allen Phelps anytime with questions. He may be reached by phone [251] 432-6533 or e-mail at: cap@adem.state.al.us.

Sincerely,

Steven O. Jenkins, Chief
Field Operations Division

SOJ/cap

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Alabama Department of Environmental Management

ADEM-1 For several years, the Governor of Alabama has continually indicated opposition to new leasing south and within 15 mi (24 km) of Baldwin County but has requested that, if the area is offered for lease, a lease stipulation to reduce the potential for visual impacts should be applied to all new leases in this area. Prior to the decision in 1999 on the Final Notice of Sale for Sale 172, this Agency's Gulf of Mexico OCS Regional Director, in consultation with the Geological Survey of Alabama/State Oil and Gas Board, developed a lease stipulation to be applied to any new leases within the 15-mi (24-km) area to mitigate potential visual impacts. The stipulation specifies requirements for consultation that lessees must follow when developing plans for fixed structures. The stipulation has been continually adopted in annual CPA lease sales since 1999. It has been considered satisfactorily responsive to the concern of the Governor of Alabama and was adopted in each of the CPA lease sales in the 2002-2007 and 2007-2012 Five-Year Programs.

The BOEM recognizes the need to protect live-bottom areas, pinnacle and topographic features, and chemosynthetic communities. Lease stipulations and NTL's to protect these resources are included in the CPA proposed actions evaluated in this Multisale EIS.

BOBBY JINDAL
GOVERNOR

SCOTT A. ANGELLE
SECRETARY

State of Louisiana
DEPARTMENT OF NATURAL RESOURCES
OFFICE OF THE SECRETARY

February 15, 2012

Mr. Gary D. Goeke, Chief
Regional Assessment Section, Office of Environment (MS 5410)
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
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New Orleans, Louisiana 70123-2394

RE: Comments on the Draft Multi-sale Environmental Impact Statement (EIS) for Gulf of Mexico Outer Continental Shelf (OCS) Oil and Gas Lease Sales 2012-2017

Dear Mr. Goeke:

The Louisiana Department of Natural Resources has received a copy of the draft Multi-sale EIS for the 2012-2017 Gulf of Mexico leasing plan. Ten (10) sales are proposed in the Gulf, five (5) each in the Western and Central Planning Areas. The first sale is proposed later this year for the Western Planning Area. While the draft Environmental Impact Statement (EIS) does set a new high in the National Environmental Policy Act (NEPA) process for OCS Lease Sales, we do not believe it has adequately evaluated cumulative, secondary and indirect impacts, nor provided for compensatory mitigation for the resulting coastal and onshore impacts. Please find our comments below.

Remaining consistent with previous comments submitted by the Department of Natural Resources, the State of Louisiana supports offshore oil and gas lease sales in the Gulf of Mexico and the development of all of our Nation's domestic energy resources. We are proud that our State is of vital importance to the petroleum industry and we wish to continue to play a prominent role in moving forward with new OCS discovery and production of these critical natural resources. The Department of Natural Resources believes that energy production in the federal waters of the Gulf of Mexico's OCS will continue to grow and be a driver for jobs, businesses, and economic recovery, and will play a key role in providing for the nation's energy needs.

LADNR-1

While Louisiana strongly favors OCS leasing, we would be remiss if we did not point out that our support of offshore energy development has impacted our State. We recognize that damage to Louisiana's coastline is not a result of one identifiable incident. Rather, damage to our coast has proliferated over time due to many actions that failed to recognize the unique and

Mr. Gary Goeke
February 15, 2012
Page 2

fragile nature of Louisiana's deltaic coast, such as management of the Mississippi River for navigation and flood control. Louisiana has endured wetland losses throughout the 50-year history of the Bureau of Ocean Energy Management (BOEM) lease sales in the Gulf of Mexico and continues to do so today. We do not believe Louisiana has received compensatory mitigation commensurate with these impacts. BOEM must take appropriate action to compensate these impacts by addressing cumulative and secondary impacts to Louisiana's coastal resources, communities, and infrastructure.

The Department of Natural Resources is pleased that BOEM has updated its data and modeling approach from the previous OCS Multi-sale EIS (2007-2012). However, we maintain the position that it is possible to better substantiate modeling methods and results in order to more objectively and adequately describe and address all impacts. In the referenced EIS, BOEM analyzed modeling forecasts and compared these with actual historical data to ensure adequate projection of exploration and production activity. Where needed, findings were adjusted by BOEM to better reflect more recent trends. The Department of Natural Resources urges BOEM to continue to more thoroughly evaluate and provide documentation of its procedures and methods by which its impact assessments are derived, as it is imperative that fair and objective impact evaluations be conducted regarding all past, current and future OCS leasing activities.

Our coastal communities and the very land upon which they stand continue to be imperiled by many factors, including the federal government's failure to adequately mitigate for impacts to coastal habitat and critical infrastructure. As it is often not possible to parse out individual operators as contributing agents, we believe compensatory mitigation largely falls to the responsible federal agency. Adequate mitigation is critical for the coastal zone to reach its full potential to provide energy, jobs, and economic strength now and into the future.

LADNR-2

We do not believe the draft EIS has included an adequate system for assessing and providing compensatory mitigation for lost habitat to the coastal states that facilitate drilling off their coasts. While the Gulf of Mexico Energy Security Act (GOMESA) provides for sharing funds associated with new production areas, account must also be taken of historic production volumes and impacts associated with such contributions to our national energy security. Louisiana is a willing host state to OCS exploration and production and incurs the consequences of those activities and thus should be adequately compensated for those impacts.

BOEM has a responsibility, under both the National Environmental Policy Act (NEPA) and the federally-approved Louisiana Coastal Resources Management Program (LCRP), to assess impacts that are induced by each lease sale, even those that are separated from the sale by distance or time. Induced impacts may include increased road and navigation channel usage in support of OCS activity as well as the costs to State and local government for building, restoring, and protecting OCS-supporting communities from floods and damage associated with tropical cyclonic activities.

Mr. Gary Goeke
February 15, 2012
Page 3

The funds from OCS energy development are one of the most significant non-tax revenue sources to the U.S. Treasury. As petroleum exploration and development has had an impact on Louisiana's coastline, the proportionate royalties from these activities should be directed to the State and provide the means to finance restoration and conservation efforts, much of which is to the benefit of the energy community and the nation as a whole. A system of revenue sharing with the Gulf of Mexico states benefits all and might influence some who presently oppose offshore exploration to reconsider their positions.

Be assured that we are committed to mitigation of these impacts. In September 2006, Louisiana voters approved a Constitutional Amendment providing that anticipated federal revenues from OCS oil and gas activity be credited to the Coastal Protection and Restoration Fund. These funds are designated expressly for the purposes of coastal wetlands conservation, restoration, and protection. Furthermore, Louisiana has crafted a United States Environmental Protection Agency Guardian Award winning *"Comprehensive Master Plan for a Sustainable Coast"* that sets forth the actions that are to be taken to restore our ecosystem and protect our coastal resources. Currently, the state is updating this Master Plan incorporating the latest scientific advances thereby providing further commitment to the restoration and protection of our coastal resources.

Louisiana recognizes that the process of accurately quantifying all impacts associated with the proposed OCS activity will not happen instantaneously. The Louisiana Department of Natural Resources looks forward to working closely with BOEM in its efforts to balance robust offshore energy development with a compensation framework that fully accounts for all social, environmental, and economic costs.

Thank you for allowing us to comment. If you should have any questions regarding these comments, please contact Mr. Jeff Harris of the Office of Coastal Management of the Louisiana Department of Natural Resources at (225) 342-7949.

Very truly yours,

Scott A. Angelle
Secretary

SSA:pso
cc: Tershara Matthews, BOEM MS 5412
Brian Cameron, BOEM MS 5412
Project folder C20110562

Louisiana Department of Natural Resources

LADNR-1 The BOEM has acknowledged the extensive loss of wetlands in Louisiana, but it has assessed the contribution of OCS oil and gas activities to that loss and has concluded that a very small percentage of the wetland loss was caused by these activities. In addition, in recent years Louisiana has received over $1 billion in offshore 8(g) revenues, over half a billion dollars in Coastal Impact Assistance Program funds, and stands to receive many more billions in offshore revenue shares in coming years from the Gulf of Mexico Energy Security Act of 2006 (GOMESA). The LADNR states that BOEM must compensate impacts to Louisiana by addressing cumulative and secondary impacts to Louisiana's coastal resources, communities, and infrastructure. The purpose of the Multisale EIS is to examine the potential impacts of a proposed action (a lease sale) on environmental and socioeconomic resources. Cumulative analyses are also included in order to put the incremental contribution of a proposed action in context considering all of the other types of activities (past, present, and reasonably foreseeable) that have the potential to cause impacts similar to those analyzed for a proposed action, including impacts from the overall OCS Program. The incremental contribution of an individual lease sale to these impacts is very small. Many of the impacts to environmental and socioeconomic resources that are identified in the cumulative analysis of the EIS have occurred over many years, much of it prior to the enactment of important laws to protect the environment and prior to the bulk of OCS activities.

LADNR-2 The BOEM has no authority to provide compensatory mitigation to the State of Louisiana in the same manner as an applicant for a Louisiana Coastal Use permit. The BOEM is not an "applicant" for its OCS lease sale activity as it does not propose specific Federal development projects in any States' coastal zone.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

December 6, 2012

Mr. Gary D. Goeke
U S Department of the Interior
Bureau of Ocean Energy Management
1201 Elmwood Park Blvd. MS 5410
New Orleans, LA 70123

Re: TCEQ Grant and Texas Review and Comment System (TRACS) #2012-020, City of Gulf of Mexico – OCS EIS/EA BOEM 2011-057

Dear Mr. Goeke:

TECQ-1

The Texas Commission on Environmental Quality (TCEQ) has reviewed the above-referenced project and offers following comments:

We look forward to reviewing the environmental assessment documents as they become available.

We do not anticipate significant long term environmental impacts from this project as long as construction and waste disposal activities associated with it are completed in accordance with applicable local, state, and federal environmental permits and regulations. We recommend that the applicant take necessary steps to insure that best management practices are utilized to control runoff from construction sites to prevent detrimental impact to surface and ground water.

Thank you for the opportunity to review this project. If you have any questions, please contact Ms. Janie Roman at (512) 239-0604 or janie.roman@tceq.texas.gov.

Sincerely,

Jim Harrison, Director
Intergovernmental Relations Division

P.O. Box 13087 • Austin, Texas 78711-3087 • 512-239-1000 • www.tceq.state.tx.us

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Texas Commission on Environmental Quality

TCEQ-1 Comments noted.

February 13, 2012

Mr. Gary D. Goeke
Chief, Environmental Assessment Section
Leasing and Environment (MS 5410)
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Via E-mail to MultisaleEIS@BOEM.gov

Dear Mr. Goeke:

The American Petroleum Institute (API), National Ocean Industries Association (NOIA), Independent Petroleum Association of America (IPAA), International Association of Drilling Contractors (IADC), International Association of Geophysical Contractors (IAGC) and the U.S. Oil and Gas Association (USOGA) offers the following comments on the U.S. Department of Interior Bureau of Ocean Energy Management's (BOEM's) Draft Environmental Impact Statement (DEIS) for five Western Planning Area (WPA) and five Central Planning Area (CPA) Gulf of Mexico (GOM) lease sales scheduled for 2012–2017 (also referred to as the Multisale EIS). On December 30, 2011, BOEM published the *Notice of Availability* in the *Federal Register* announcing publication of the DEIS and requesting comments on or before February 13, 2012. Collectively, the associations listed above represent the vast majority of the U.S. oil and natural gas industry – a vital part of our nation's economy. The industry supports millions of American jobs and delivers billions of dollars in annual revenue to our government. Last year, it directly contributed more than $470 billion to the U.S. economy in spending, wages and dividends, and it is one of the few industries creating jobs throughout the recession and the ongoing national economic downturn.

The API is a national trade association that represents over 490 members involved in all aspects of the oil and natural gas industry, including exploring for and developing oil and natural gas resources in the GOM– a vital part of our nation's economy. The industry supports millions of American jobs and delivers billions of dollars in annual revenue to our government. Last year, it directly contributed more than $470 billion to the U.S. economy in spending, wages and dividends, and it is one of the few industries creating jobs throughout the recession and the ongoing national economic downturn.

The National Ocean Industries Association, founded in 1972, represents more than 270 companies among all segments of the offshore industry with an interest in the exploration and production of both traditional and renewable energy resources on the nation's outer continental shelf. NOIA's mission is to secure reliable access and a fair regulatory and economic environment for the companies that develop the nation's valuable offshore energy resources in an environmentally responsible manner.

The IPAA is a national trade association representing over 5,000 oil and natural gas producers that drill 90 percent of the nation's oil and natural gas wells. These companies account for 54 percent of America's oil production and 85 percent of its natural gas production. The members of IPAA that operate in the OCS are dedicated to energy production from the domestic offshore and are extremely interested in the development of the OCS 5-Year oil and gas leasing program.

The IADC is dedicated to enhancing the interests of oil-and-gas and geothermal drilling contractors worldwide. The IADC is the sole trade association representing virtually the entire global oil and natural gas drilling industry, both onshore and offshore. IADC's membership of more than 1,600 companies also includes oil-and-gas producers, and manufacturers and suppliers of oilfield equipment and services. Headquartered in Houston, it also has permanent offices in Washington DC, The Netherlands, Dubai and Thailand, and chapters on every continent except Antarctica.

The IAGC is the international trade association representing the industry that provides geophysical services (geophysical data acquisition, processing and interpretation, geophysical information ownership and licensing, associated services and product providers) to the oil and gas industry. IAGC member companies play an integral role in the successful exploration and development of offshore hydrocarbon resources through the acquisition and processing of seismic data.

The USOGA is a national trade association for the oil and gas industry established in 1917 in Tulsa, OK. USOGA currently has about 4,500 members and in addition to its Washington, DC headquarters has Divisions in Alabama/Mississippi, Louisiana, Oklahoma and Texas.

BOEM's EIS addresses 10 proposed Federal actions that offer for lease areas on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) that have historically contained substantial reserves of economically recoverable oil and gas resources. The WPA and CPA of the Gulf of Mexico constitute one of the world's major oil and gas producing areas, and have proved a steady and reliable source of U.S. crude oil and natural gas for more than 50 years. Under the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017* (5-Year Program), five annual areawide lease sales are scheduled for the Western Planning Area (WPA) and five annual areawide lease sales are scheduled for the Central Planning Area (CPA). The proposed WPA lease sales are Lease Sale 229 in 2012, Lease Sale 233 in 2013, Lease Sale 238 in 2014, Lease Sale 246 in 2015, and Lease Sale 248 in 2016; the proposed CPA lease sales are Lease

Sale 227 in 2013, Lease Sale 231 in 2014, Lease Sale 235 in 2015, Lease Sale 241 in 2016, and Lease Sale 247 in 2017.

The CPA and WPA are critically important hydrocarbon energy producing areas where existing infrastructure and expertise can be used to increase our nation's oil and natural gas resources. And, they are the only OCS areas where industry is offered opportunities to explore for oil and natural gas resources on a regular basis. Predictable lease sales in these Planning Areas are needed to help ensure continued offshore exploration and production in the future since leases sold today will take many years to fully develop. Predictability and certainty in the leasing program helps companies make the long-term decisions required for offshore development and avoids the potential of having years wasted in bringing production to the market.

<u>BOEM's NEPA Analysis</u>

We strongly support the analysis made by BOEM in the Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017 Draft Environmental Impact Statement (OCS EIS/EA BOEM 2011-057). We believe that the detailed analysis provided in the DEIS, along with the other supporting environmental documents and additional assessments being conducted by BOEM, provide a thorough analysis upon which to make decisions related to the 10 proposed lease sales, new or revised exploration and development plans in the Western and Central Planning Areas, and future permit applications, without delay. We note that the 2012-2017 GOM Multisale DEIS contains updated information and analyses regarding the 2010 Macondo oil spill. This new information supports the NEPA process by describing the current environmental baseline conditions in the CPA and WPA including the results of numerous new scientific studies regarding the spill. We encourage BOEM to continue reviewing and evaluating the sound, peer-reviewed science in this area and to avoid the use of unsubstantiated or antidotal information.

We also acknowledge that BOEM has conducted a detailed Catastrophic Spill Event Analysis at Appendix B of the DEIS to consider the environmental impacts associated with a low probability high-volume oil spill resulting from loss of well control on the Gulf of Mexico OCS. We believe that this analysis fully meets the agency's obligations under NEPA to provide decision makers with a robust analysis of reasonably foreseeable impacts associated with a low probability oil spill on the OCS.

<u>Tiering Under the National Environmental Policy Act (NEPA)</u>

Since each lease sale proposal and projected activities are very similar each year for each sale area, BOEM is preparing a single EIS for the 10 WPA and CPA lease sales. We support BOEM's approach of evaluating multiple similar federal actions (i.e. holding multiple lease sales) in a single EIS as provided in the Council on Environmental Quality's (CEQ's) regulations (see 40 CFR 1502.4). We are aware that at the completion of this EIS process, agency decisions will be made only for proposed Lease Sale 229 in the WPA and proposed Lease Sale 227 in the CPA. We understand that a NEPA review will be conducted before each subsequent lease sale following lease sales 229 and 227. We believe that this approach will allow the NEPA reviews of the subsequent lease sales to proceed efficiently by focusing on any new issues or information and avoiding the repetitive issuance of cumbersome draft and final EISs for each sale area. In short, we support BOEM's continued practice of tiering EISs and Environmental Assessments (EISs/EAs) under NEPA.

<u>Alternatives Considered in the SEIS</u>

The DEIS considers three alternative for proposed WPA lease sales 229, 233, 238, 246, and 248 and three separate (but similar) alternatives for proposed CPA lease sales 227, 231, 235, 241, and 247. We support Alternatives A (the *Proposed Action*) for the proposed WPA and CPA lease sales as described below:

<u>WPA lease sales 229, 233, 238, 246, and 248</u>
Alternative *A—The Proposed Action*: This alternative would offer for lease all unleased blocks within the WPA for oil and gas operations, except the following:

(1) Whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary; and
(2) Whole and partial blocks that lie within the former Western Gap and are within 1.4 nautical miles (nmi) north of the continental shelf boundary between the U.S. and Mexico

<u>CPA lease sales 227, 231, 235, 241, and 247</u>
Alternative A (Preferred Alternative)—The Proposed Action: This alternative would offer for lease all unleased blocks within the CPA for oil and gas operations, with the following exceptions:

(1) Blocks that were previously included within the Eastern Planning Area (EPA) and that are within 100 mi of the Florida coast;
(2) Blocks east of the Military Mission line (86 degrees, 41 minutes west longitude) are not offered until 2022 as a result of the Gulf of Mexico Energy Security Act of 2006 (December 20, 2006);
(3) Blocks that are beyond the U.S. Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and
(4) Whole and partial blocks that lie within the former Western Gap and are within 1.4 nmi north of the continental shelf boundary between the U.S. and Mexico.

API-1

We are opposed to alternatives B and C identified for the WPA and CPA lease sales. Alternative B is described as *The Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features* for both the WPA and CPA lease sales. In essence, Alternative B is the *Proposed Action* (Alternative A) for the WPA and CPA except that blocks near biologically sensitive topographic features (subject to the Topographic Features Stipulation) would be excluded from leasing. Alternative C is described in slightly different terms for the proposed WPA and CPA lease sales as the *No Action* alternatives. For the WPA, Alternative C is described as "the cancellation of a lease sale." For CPA lease sales, Alternative C is described as "the cancellation of one or more proposed CPA lease sales." The analysis in the DEIS does

API-1 not support the adoption of such restrictive alternatives. We strongly urge BOEM to adopt Alternative A for both the WPA and CPA cases.

API-2 While we support Alternative A, we are concerned that current plans by the National Oceanic and Atmospheric Administration (NOAA) Office of National Marine Sanctuaries described in the *Flower Garden Banks National Marine Sanctuary Draft Management Plan* (October 2011) could dramatically expand the boundaries of the sanctuary and unnecessarily limit access to vital oil and gas resources in the Gulf of Mexico. The draft management plan describes several options to dramatically expand the size of the existing East and West Flower Garden Banks (including the nearby Stetson Bank) and to add six or more new bank areas to the existing boundaries of the Flower Garden Banks National Marine Sanctuary (FGBNMS). Under BOEM's Alternative A for the Western Planning Area, these future additions to the FGBNMS (should they occur) would be automatically excluded from future oil and gas lease sales in the Western Planning Area. We also note that the proposed additions to the FGBNMS would extend into the Central Planning Area resulting in uncertainty regarding future oil and gas leasing in these areas as well. We strongly oppose any future actions to automatically exclude possible future additions to the FGBNMS from consideration for future oil and gas lease sales. As such, we suggest that WPA Alternative A be reworded to make it clear that the leasing exclusion would only apply to those blocks and partial blocks within the existing boundaries of the FGBNMS as it existed on January 1, 2012.

We note that directional drilling allows access to oil and gas resources located beneath sensitive resources by offsetting the bottom disturbing activity (e.g. drilling rig surface location) from sensitive areas. In addition, we believe that the existing Topographic Features and Live Bottom Stipulations routinely included in BOEM's Proposed Notice of Sale and other agency guidance documents is sufficient to identify and avoid harm to live bottom communities. In particular, we believe that the substantial requirements contained in BOEM's Notice to Lessees No. 2009-G39 (no activity zones, required surveys and maps, photodocumentation, bottom disturbing activity offsets from sensitive areas, shunting drill cuttings to the sea floor, etc.) are sufficient to protect sensitive marine habitats. As such, we are strongly opposed to automatically excluding any expanded FGBNMS areas from future leasing and believes that any such consideration would trigger additional NEPA analysis both by NOAA and BOEM to allow stakeholder and public comments to be fully considered.

Suggestions for Finalizing the EIS

API-3 While we believe that BOEM's DEIS for the ten proposed 2012-2017 GOM lease sales is well written and supported by references to applicable scientific studies, as with any such endeavor, the document could be made even stronger. We recognize the need for a "cut-off point" for new information so that the administrative process for finalizing the EIS can proceed. Nonetheless, including a number of the technical reports that have been published since the DEIS was prepared would be helpful in understanding recent oil spills and other issues and could further inform the NEPA process for the upcoming GOM lease sales. To this end, we submit two enclosures to this letter that provide recommendations for strengthening the EIS. Enclosure 1, *Comments on the 2012-2017 GOM Multisale DEIS*, is a table that presents comments that generally reference a specific section or page within the GOM Multisale DEIS or, in some cases, address more general issues. Enclosure 2, *Detailed Technical Comments on 2012-2017 GOM Multisale DEIS*, is focused on describing recent scientific findings that are helpful in understanding the impacts of oil and gas operations on specific resource areas (e.g., water quality, air, fish, marine mammals, etc.). In particular, Enclosure 2 describes recent scientific research concerning the DWH event that will be helpful in more fully describing the potential consequences of a large offshore oil spill. We offer both Enclosures 1 and 2 for the Agency's consideration in developing the final EIS for the 10 WPA and CPA lease sales proposed in the GOM between 2012 and 2017.

In addition to the comments included in the enclosures, we offer the following additional suggestions for consideration by BOEMRE.

1. **The Need to Streamline the DEIS:**

API-4 We believe that the 2012-2017 GOM Multisale DEIS could benefit from additional editing and a general attempt to reduce or eliminate redundancy. Because of its large size and complex organization, the document is challenging to use without careful study and a significant investment of time. We note that the DEIS document has grown to three large volumes and is well over 2,000 pages in length. While there is a clear need to be comprehensive with the GOM Multisale DEIS (as it will provide information for future NEPA tiering) we believe that there is significant redundancy that can be eliminated without deleting important information or detracting from the usefulness of the document as a decision making tool. For example, Section 4 is currently almost 1,000 pages in length. Sections 4.1 and 4.2 describe resources and impacts in the Western and Central Planning Areas respectively. The lengthy descriptions for the most part are Gulf-wide in nature and repeated nearly verbatim in both sections. BOEM could reduce the size of this chapter by many hundreds of pages by presenting the general resource description and impact assessment followed by separate headings for each planning area where the discussion is focused on only those items unique to that planning area. Sections 3.1.1.2 and 3.1.1.3 show where this approach has been used (i.e. a general discussion of an impact producing factor followed by a refinement of the discussion to WPA and CPA typical sales and the OCS Program Cumulative Scenario) to condense the necessary discussion. While Chapter 4 represents the largest opportunity to streamline the DEIS, the entire document would benefit from a vigorous editorial review to eliminate unnecessary redundancy and improve its organization.

2. **Discussion of BOEMRE's recent rule changes**

API-5 We suggest that BOEM further enhance Section 1.3.1, *Rule Changes Following the Deepwater Horizon Incident* (see page 1-7), to more completely describe the administrative and regulatory changes made by the Agency following the DWH blowout and oil spill. Collectively, these changes have been implemented in an effort to further reduce the risk of future blowouts and oil spills on the U.S. Outer Continental Shelf. In particular, We suggest that this section summarize the intent and requirements of Notice to Lessees (NTL) 2010-N06, and 2010-N10. These NTLs are listed but not summarized or explained in Section 1.3.1. Further, this section describes the fact that the Bureau of Safety and Environmental Enforcement (BSEE) will institute "enhanced inspection procedures" but does not discuss any specifics regarding these enhancements.

API-5

We note that BOEM prepared a similar but somewhat more comprehensive discussion of the regulatory reforms implemented since the Deepwater Horizon event in the *2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS* (OCS EIS/EA BOEM 2011-001) at Section 4.3.4.3.4 (pages 4-90 to 4-99). We suggest that BOEM augment some of the discussion in the GOM Multisale DEIS with the updated and more thorough discussion of this topic in the five-year lease sale Draft Programmatic EIS. While we continue to have concerns over the manner by which some of these new regulatory requirements were developed and implemented (e.g., Notices to Lessee and interim final rules used in lieu of rulemaking), we do believe industry is operating in compliance with the new requirements; and they have resulted in reducing risks. In addition, several important new initiatives to reduce the risk of offshore operations and greatly increase spill response capabilities have been implemented and others are underway. Taken together, these regulatory, policy, and industry led initiatives work to further reduce the risk of future incidents and improve the offshore industry's ability to respond to accidents or oil spills. We believe the discussion is important from a NEPA perspective because it describes BOEM's regulatory, administrative, and procedural adjustments following the Deepwater Horizon DWH incident to reduce the risk of similar incidents in the future. While "tiering" from the 2012-2017 five-year lease sale Draft Programmatic EIS would be possible, we believe that this discussion is worthy of a complete and independent presentation in the GOM Multisale DEIS.

3. Impacts from a catastrophic spill event

API-6

Appendix B, *Catastrophic Spill Event Analysis,* is an important component of the GOM Multisale DEIS and should be introduced in the Executive Summary and discussed within appropriate sections of the document. We recommend that a brief summary or acknowledgement of the NEPA purpose of Appendix B be included in the Executive Summary (currently at pages vii through xv) and in Section 2. Section 2.2.3.1 *Issues to be Analyzed* might be an appropriate section to introduce the logic and purpose behind including Appendix B in the DEIS. Appendix B represents an analysis of the potential environmental effects of a high-volume, extended-duration, catastrophic oil spill from a well blowout in the Gulf of Mexico. While the term, "catastrophic spill," is described in Appendix B, it is used in several places in Chapter 2 and beyond without prior definition (see page 2-15 at Section 2.3.1.2 under the heading *Water Quality: Offshore Waters.* At some point before these discussions, it would be helpful to refer the reader to the *Catastrophic Spill Event Analysis* in Appendix B, where a catastrophic spill is defined on pg. B-12.

4. Discussion of "Incomplete and Unavailable" Information

At pp. 4-5 through 4-9 (Western Gulf), pp. 4-436 through 4-438 (Central Gulf), and in the discussions following each of those sections, the GOM Multisale DEIS addresses the instances in which the information available to BOEM is "incomplete or unavailable" within the meaning of 40 C.F.R. § 1502.22. BOEM specifically addressed whether the currently unavailable information is not "relevant to making a determination regarding reasonably foreseeable significant adverse impacts," or whether the currently unavailable information is not "essential to a reasoned choice among alternatives," or whether, even if the currently unavailable information *might* be essential, that information could be obtained and whether the cost of obtaining the information is exorbitant, and whether generally acceptable scientific information could be applied in its place, *see* 40 C.F.R. § 1502.22(a & b).

In all instances, BOEM concluded either that the incomplete or unavailable information was not relevant; or that it was not essential; or that if even it might be essential, the information either could not be obtained or could not be obtained except at exorbitant costs, and that in all instances, the Agency had sufficient information reasonably to evaluate foreseeable significant adverse impacts on the human environment. These conclusions are important, since both CEQ regulations and case law spell out how an agency must proceed when confronted by information that is not currently available.

A. Standards for addressing information that is incomplete and unavailable.

Under NEPA, agencies need not wait to finalize an EIS or other NEPA-mandated analysis until all possible potentially relevant information is available. *E.g., Sierra Club v. Sigler*, 695 F.2d 957, 973 (5th Cir. 1983) ("Uncertainty as to environmental consequences need not bar action as long as the uncertainty is forthrightly considered in the decision making process and disclosed in the EIS"); *see State of Alaska v. Andrus*, 580 F.2d 465, 473 (D.C. Cir. 1978), *vacated in part on other grounds*, *Western Oil & Gas Ass'n v. Alaska*, 439 U.S. 922 (1978); 40 C.F.R. § 1502.22. In *State of Alaska*, the D.C. Circuit held: "agencies may not be precluded from proceeding with particular projects merely because the environmental effects of that project remain to some extent speculative. NEPA simply does not specify the quantum of information that must be in the hands of a decisionmaker before that decisionmaker may decide to proceed with a given project." *Id.* The court stated:

> "NEPA was intended to ensure that decisions about federal actions would be made only after responsible decisionmakers had fully adverted to the environmental consequences of the actions . . . ." One of the costs that must be weighed is the cost of uncertainty, i.e., the costs of proceeding without more and better information. Where that cost has been considered, and where the responsible decisionmaker has decided that it is outweighed by the benefits of proceeding with the project without further delay, the courts may not substitute their judgment for that of the decisionmaker and insist that the project be delayed while more information is sought.

Id.; see, e.g., Cabinet Res. Grp. v. United States Fish and Wildlife Serv., 465 F. Supp. 2d 1067, 1100 (D. Mont. 2006) (sufficient that "the Forest Service used available data to explore the potential impacts and articulated the basis for its decision").

In 40 C.F.R. § 1502.22, the CEQ specifies the steps that an agency should take when confronted with potentially relevant information that is not currently available. Initially, the agency must disclose that such information is not available: "When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment . . . and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking." 40 C.F.R. § 1502.22. Here, the GOM Multisale DEIS documents the instances in which the information currently available is incomplete, and identifies the subject areas in which ongoing or future studies may produce additional information. The GOM Multisale DEIS also acknowledges the extensive data collection and evaluation work now underway as part of the

Natural Resource Damage Assessment process relating to the Deepwater Horizon event and other scientific endeavors. *E.g.*, DEIS at p. 4-437 ("it could be many years before" the conclusions of NRD assessment work and the "numerous studies by academia" become available).

Once the fact of currently unavailable information has been identified, an agency must evaluate the relevance and importance of this information. 40 C.F.R. § 1502.22(a). Where the agency determines that unavailable information (1) is not "relevant to reasonably foreseeable significant adverse impacts" from the alternatives before it or (2) is not "essential to a reasoned choice" between alternatives, the agency need not go further in seeking out or evaluating this information prior to issuance of the NEPA analysis document. *Cabinet Res. Grp.*, 465 F. Supp. 2d at 1100 (emphasis added) (citing 40 CFR § 1502.22(a)) ("The obligation to disclose and compensate for missing information is triggered only where the information is 'essential to a reasoned choice among alternatives.'").

Finally, even if the unavailable information is found to be both relevant and "essential" to a reasoned choice among alternatives, the agency may proceed to finalize an EIS or other NEPA analysis without waiting to obtain the information provided that, after weighing the need for and importance of the information in question against the costs and burdens required to obtain it, the agency concludes such costs and burdens would be "exorbitant." 40 CFR § 1502.22(b). In the GOM Multisale DEIS, BOEMRE addresses these issues through its extensive discussions in Part 4 of the document, which initially identifies certain specific types of information that "*may* be essential," *see* pp. 4-7, 4-438 (emphasis added), but then after close analysis of each information type ultimately concludes that it is not possible for BOEM—regardless of the cost—to obtain final information within the timeline of the EIS, and that in all instances BOEM subject-matter experts have adequately assessed environmental impacts by relying upon available credible scientific evidence and applying it using scientifically accepted methodology.

B. Additional Steps To Strengthen Analysis Of Unavailable Information.

In the GOM Multisale DEIS, BOEMRE has identified where information that is potentially relevant to the conclusions of its NEPA analysis is "unavailable or incomplete," assessed the possible relevance and importance of this information to a "reasoned choice" between the alternatives under study, and reached a determination that the unavailable information is either not relevant or not essential to its conclusions in this document, or where that information may be essential, why it is nonetheless appropriate to proceed with the completion of the EIS. The GOM Multisale DEIS further addresses instances in which specific items of information are not currently available in Part 4 as part of discussions of how the project alternatives may impact particular categories of resources. Through this discussion, BOEM has appropriately addressed the requirements of 40 C.F.R. § 1502.22.

This is especially true given that the draft and final EIS must ultimately be evaluated against the backdrop of the governing standard for offshore oil and gas leasing, exploration and development, the OSC Lands Act. That Act itself requires that the OCS be made available for expeditious exploration and development, *e.g.*, 43 U.S.C. § 1802(1), 43 U.S.C. § 1332(3), and specifies that decisions regarding leasing and other matters are to be made on the basis of "available" and "relevant" environmental information, 43 U.S.C. § 1346(d). The draft EIS has provided the information and analysis necessary to fulfill NEPA obligations, especially in the context of these OCS Lands Act requirements and guidelines.

On May 20, 2011, BOEMRE issued its draft Chukchi Sea SEIS for Lease Sale 193 in the Chukchi Sea Planning Area in Alaska. This supplemental NEPA analysis was prepared in response to the 2010 decision, *Native Village of Point Hope v. Salazar*, 730 F. Supp. 2d 1009 (D. Alaska 2010), which found certain deficiencies in the manner in which the EIS originally prepared for Lease Sale 193 had addressed "incomplete or unavailable information." 730 F. Supp. 2d at 1018 (the EIS should be revised to "make the findings" required by 40 C.F.R. § 1502.22). In preparing the newly-issued draft SEIS, BOEMRE developed a thoughtful and very useful framework to evaluate information that is currently not available and to make any required findings under § 1502.22. This approach, if suitably modified for the different circumstances, requirements, and factual context of the present draft SEIS, offers an opportunity for BOEMRE to further strengthen its analysis of "incomplete or unavailable" information.

In Appendix A to the draft Chukchi Sea SEIS, BOEMRE describes the "structured analysis" used in making the 40 C.F.R. § 1502.22 findings called for by the *Native Village of Point Hope* decision. BOEMRE adopted more specific definitions of certain key terms used in § 1502.22. Thus, information "was considered relevant if it could be connected to reasonably foreseeable significant adverse impacts as stipulated by CEQ regulation and following the significance criteria" spelled out in the draft SEIS. App. A, at A1 (emphasis in original); *see, e.g., Mid States Coalition for Progress v. Surface Transp. Bd.*, 345 F.3d 520, 549 (8th Cir. 2003). If relevant, information was then evaluated "to determine whether the information was essential to a reasoned choice among alternatives. To be essential, the information must provide a clear distinction between two or more alternatives." App. A, at A1 (emphasis in original); see *Cabinet Res. Grp.*, 465 F. Supp. 2d at 1100. If information was found to be both relevant and essential, the agency "evaluated the potential means of obtaining the information to determine whether cost would be exorbitant." App. A, at A1 (emphasis in original); *see State of Alaska*, 580 F.2d at 473.

Applying these definitions, BOEMRE proceeded to analyze the "hundreds of catalogued statements" mentioning incomplete or unavailable information compiled by parties challenging the original Chukchi Sea EIS. App. A, at A2. In doing so, the agency identified "common themes" concerning how such statements should be addressed under 40 C.F.R. § 1502.22. Among those most pertinent are:

- Sufficient information to support sound scientific judgments and reasoned managerial decisions is available even without the identified incomplete or unavailable information. As BOEMRE explained, although "there will always be some level of incomplete information (especially regarding dynamic ecosystems), there is often enough information to formulate and support sound scientific judgments." App. A, at A3.

- The realization that significant adverse effects could certainly occur under the circumstances to which the incomplete information applies. As an example, "it is already presumed that a large oil spill could cause significant adverse impacts to wildlife and other resources, through myriad direct and indirect effects. Thus, it is not essential for the decision-maker, who is already made aware of the probability and severity of these potential impacts, to understand every particular mechanism through which these adverse impacts could occur." App. A, at A3.[1]

- The existence of other environmental laws and regulations that would preclude significant adverse effects on particular resources. "For example, comprehensive regulatory standards under the Clean Air Act are sufficient to preclude air quality impacts from reaching a level of significance. Incomplete information regarding air quality issues is in this sense less useful to the decision maker . . . ." App. A, at A3.
- The understanding that certain presently missing or incomplete information will be known (and utilized to avoid or minimize impacts) at a later stage of the agency's environmental review. Due to the multi-stage process for "planning, leasing, exploration, and development and production of oil and gas" on the OCS, the fact that "certain information may, in fact, be essential at a later stage of OCS Lands Act [review]" does not imply that this information is "essential to a reasoned choice among alternatives at this lease sale stage." App. A, at A3.[2]

Equipped with these principles, BOEMRE proceeded to address, and make individualized findings as to each of the many "catalogued statements" in the original Chukchi Sea EIS. App. A, at A3-A98.

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It might be useful for BOEM to include in the Final EIS a discussion of these same themes, and summarize its ultimate conclusions why 40 C.F.R. § 1502.22 requirements have been fully satisfied, and why waiting for additional information would be entirely inappropriate. Even where such discussion is not essential as a legal matter to comply with 40 C.F.R. § 1502.22, it could be helpful in further explaining and supporting the Agency's conclusions in this regard.

In closing, the oil and natural gas industry stands ready to invest in safe exploration and development of the GOM. The resources of the GOM remain a vital source of jobs, revenue, energy and economic growth. We believe that these resources can be safely developed, and we ask that the department finalize the 2012-2017 Multisale DEIS as quickly as possible so that leasing can continue in accordance with Alternative A as proposed in the DEIS.

[1] *E.g., No GWEN Alliance of Lane County, Inc. v. Aldridge*, 855 F.2d 1380 (9th Cir. 1988) (noting that when "everyone recognizes that . . . effect" may be catastrophic, requiring detailed delineation of the precise nature of the impacts "serve[s] no useful purpose").

[2] See *North Slope Borough v. Andrus*, 642 F.2d 589 (D.C. Cir. 1979).

Sincerely,

Andy Radford, API

Luke Johnson, NOIA

Dan Naatz, IPAA

Alby Modiano, USOGA

Walt Rosenbusch, IAGC

Brian Petty, IADC

API ENCLOSURE 1 (API 1) COMMENTS 1-6

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

No..	DEIS Section No.	Page No.	COMMENT
1	General	NA	The amount of information and level of detail presented in this multi-sale DEIS should allow for significant tiering / incorporation by reference of material in future Lease Sale specific NEPA reviews.
2	General	N/A	The overall report needs a list of acronyms.
3	General	N/A	The DEIS should provide more information on the relative effects to the many resources evaluated because of climate change. Although there are a few resource areas provided where this is addressed, as a whole the document does provide the public a clear understanding how all anthropogenic and non-anthropogenic impacts are synergistically assessed in the cumulative sections of the various resource evaluations. Recent (2010) information has noted the necessity for addressing climate change evaluations during cumulative impact assessments: http://www.iaia.org/iaia-climate-symposium-dc/proceedings/iaia/day%201/3_IAIA%20Symposium%20on%20Climate%20Change%20and%20EIA_NEPA%20Presentation_World%20Bank_Nov%202010_Michael%20Smith.pdf. Also, see global climate change effects on salinity and temperature in GOM: http://www.usgcrp.gov/usgcrp/Library/nationalassessment/gulfcoast/gulfcoast-chapter6.pdf
4	General	N/A	Recent reports by Joseph Mason, LSU July 2010, contains OCS facts and information that could be cited within this EIS. The Economic Cost of the Moratorium on Offshore Oil and Gas Exploration to the Gulf Region – July 2010: http://www.noia.org/website/download.asp?id=40016 and The Economic Contribution of Increased Offshore Oil Exploration and Production to Regional and National Economies - February 2009: at http://www.americanenergyalliance.org/images/aea_offshore_updated_final.pdf
5	General	N/A	It would be helpful to have the referenced Tables within the section they are being analyzed and described especially if only electronic text is available.
6	General	N/A	The Economics Section lacks a description on tax and royalty revenues generated from off-shore drilling. The percentages related to implementation of policy actions either in favor or opposition of OCS programs could pose significant impacts to local economies (i.e. Educational revenues, etc.)…with some local economies being more sensitive than others. One case in point would be La Fourche Parish.

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API 1 COMMENTS 7-12

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

7	General	N/A	The Socioeconomic Section lacks a description of potential burdens related to onshore Existing Community Services such as hospitals, firefighters, and emergency services (that might be utilized in accident events).
8	General	Air Quality	NOTE: The air quality comments were derived by reviewing only the WPA discussion in the EIS. The air quality discussion for the CPA was also reviewed because we found that it uses in many instances duplicated text from the WPA discussion. Therefore, the comments below apply to both sections of the EIS. In general, the air quality discussion does not give the reader a full understanding of the potential air quality impacts of the specific lease activities in either area. The sections reference background information available from literature sources and previous studies in the Gulf; the pertinent information from these references, in general, are not summarized in the document. The only quantitative estimate of potential air quality effects are two tables of estimated annual emissions from each area and the procedures used to derive these emission estimates are not fully discussed in the sections reviewed.
9	General	Air Quality	Although GHG emissions are shown in the two summary emission tables (Table 4-2 and 4-64 in Volume 3), a discussion and analysis of the GHG emissions in the context of the need to address GHGs in a NEPA document is not presented. A review of the following guidance should be done: "Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions", issued February 18, 2010 Memorandum from CEQ to Heads of Federal Departments and Agencies: the Mandatory Reporting Rule, and the new GHG permit requirements.
10	General	Socioeconomics	There is considerable redundancy throughout the socioeconomic section of the report. Each section should concentrate only on the topic for analysis; i.e. economics or EJ, instead of re-describing the proposed action or impact area.
11	Summary	pg. x thru xv	The impact conclusions for only some of the topic areas summarize the anticipated cumulative effects. All the impact summaries should have a similar format and contain the same type of information. Some summaries use minor when describing impacts and other talk about short-term adverse. There should be a consistent approach or there should be a definition for each. It would be helpful if cumulative impacts were included in each of the summaries.
12	Summary		Many of these summaries do not present a cohesive argument about how the impact conclusion was drawn. As a result, some of the impact conclusions appear to be drawn arbitrarily. The following comments on the summaries are not meant to be comprehensive, but are meant to illustrate the issues found in the summaries.

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API 1 COMMENT 12

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

	Air Quality	pg. x	This summary does not address offshore air quality. If offshore air quality is not evaluated, this should be stated. This summary is missing any conclusion about cumulative impacts.
	Coastal and Offshore Waters	pg. xi	This summary is missing any conclusion about cumulative impacts from routine activities.
	Coastal Barrier Beaches and Associated Dunes	pg. xi	The summary is more comprehensive than those provided for most resource areas. It includes direct, indirect and cumulative impacts and provides time and location information for the impacts. This summary should be the model after which the other summaries should be modeled.
	Sargassum	pg. xii	This summary says that there could be minor effects, but does not state what the effects would be.
	Soft Bottom	pg. xii	The way that this summary is written suggests that there would only be significant effects if the entire WPA or CPA were impacted. The summary should be rewritten to clarify what a significant impact would be.
	Marine Mammals	pg. xii	The discussion of marine mammal's is written to suggest that there would be short-term adverse effects on marine mammals from routine activities. Please clarify. This summary ends by stating that is likely to be sublethal impacts. This statement should be followed be followed by one or two sentences stating why. Is this based on historical evidence? Are sublethal impacts considered significant?
	Sea Turtles	pg. xii	The statement in this summary infers that harm to sea turtles from routine activities are "unlikely to rise to a level of significance due to activity already present in the Gulf of Mexico and mitigations that are in place." This statement is difficult to interpret without knowing how the "level of significance" is defined and what other activities are occurring in the GOM. It would be helpful if the cumulative conclusion in this summary was characterized more effectively. While

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API 1 COMMENTS 12-16

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

			non-OCS energy related activities may have had a greater historical impact, the analysis of cumulative should consider the contribution of impacts from the proposed action to the historical, present, and anticipated impacts. Will this proposed action contribute to a cumulatively significant threat to sea turtles given the other impacts to sea turtles?
	Terrapins	pg. xii	This summary is missing any conclusion about cumulative impacts from routine activities.
	Beach Mice	pg. xii	Provide a rationale for the conclusion that consumption of trash is unlikely to have an impact to the mice.
13	Sec. 4.1 & 4.2	General	The **Description of the Affected Environment, Impact of Routine Events, Impacts of Accidental Events,** and **Cumulative Events** presented in Sections 4.1 and 4.2 contains information that is Gulf wide in nature or common to both Areas and therefore could be presented once. This allows the Area specific information to be presented more concisely and with a short reference back to the general Gulf information when needed. The present approach makes finding unique Area information difficult. For example, Pages 4-183 to 4-214 (Marine Mammals) contain virtually the same information as pages 4-689 to 4-721. Alternatively, Section 4 could be presented in a manner similar to Sections 3.1.1.2 and 3.1.1.3 to reduce the repetitive information.
14	4.1.1.1.2	General	This section should discuss the annual projected emissions of GHGs that are shown in Table 4-2. Typical individual well site annual GHG emissions should be shown and compared to annual GHG reporting requirements under the Mandatory Reporting Rule (MRR) in order to understand if well sites will need to report emissions under the MRR. There are also air permit emission thresholds for GHGs in place that are not addressed. A discussion is needed on how these permit requirements relate to development activities in the WPA.
15	4.1.1.1.3	General	If possible, the discussion of impact of accidental events should be more thorough and present results of an impact analysis. The discussion only touches on possible effects in general terms and seems to reflect a limited literature review. In addition, emissions of Hazardous Air Pollutants (HAPs) should be addressed.
16	4.1.1.1.4	General	In general, the cumulative impacts section does not discuss cumulative impacts. The section includes a Background/Introduction subsection, but would benefit from an Impacts Analysis section. The section also does not discuss the contribution of GHG emissions from proposed activities in the context of other sources of GHG emissions or statewide/nationwide GHG

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API 1 COMMENTS 17-23

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

			emissions.
17	1.1	1-3	Paragraph 1: This EIS "will be the only National Environmental Policy Act (NEPA) document prepared for proposed WPA Lease Sale 229 and proposed CPA Lease Sale 227" and that "An additional NEPA review will be conducted for each subsequent proposed lease sale in the 5-Year Program". This text implies that this EIS and the additional NEPA reviews for each subsequent lease sale will provide additional detailed analysis of the lease sales proposed for each year. The air quality sections 4.1.1.1 (WPA) and 4.2.1.1 (CPA) do not appear to present a specific air quality analysis. It is unclear if the emissions presented in Table 4-2 and Table 4-64 are only for WPA Lease Sale 229 and CPA Lease Sale 227, respectively, or if they are average expected by year for all lease sales. The final EIS would benefit from additional clarification in this area.
18	1.1	1-3	This section documents the historical need for oil and gas but does not include the forecasted need and demand for oil and gas in the short-, near-, and long-term. The Energy Information Administration has these forecasts for 2010 and 2011. Including the forecast about need for oil and gas would strengthen the discussion.
19	1.3	1-5	Section 1.3 should be revised to address the regulations of the other cooperating and commenting agencies, from which the lessee will require approvals and are intended to further protect the environment from specific activities beyond the scope of BOEMRE's comprehensive regulations as this NEPA document will support decisions by these other agencies on future lease sales.
20	1.3	1-5 thru 1-6	Recommend that the chart on pages 1-5 and 1-6 be assigned a table number comparable to other similarly formatted text. Further, the table could be expanded to show how each of the applicable regulations are addressed in the lease sale.
21	1.3.1	1-8 thru 1-11	To increase the readability of this section, a table could be added that summarizes the changes in regulation. The columns would be: Previous Requirement, New Requirement, and Rationale for Change.
22	1.4	1-12	Paragraph 1: It would be useful to indicate where scoping meetings occurred rather than only the states in which they occurred to demonstrate the comprehensive nature of scoping.
23	1.5	1-26 thru 1-28	As discussed above (Section 1.3 page 1-5), it is unclear why air emissions, archeological resources regulation, and coastal zone management consistency are discussed and no other non-BOEM regulations. To decrease the length of this suggestion, it is recommended that these discussions be deleted and that the table on p. 1-5 be modified to include a column that includes the location of the discussion of the law or regulation in the document.

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API 1 COMMENTS 24-32

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

24	2.2.1.1	Fig. 2-1 & 2-4	The figures would be more useful if the unleased block could be shown along with those areas excluded (leased, biologically sensitive, and stipulation areas).
25	2.2.1.1	Table 2-2 & 2-5	The discussion of the OCS blowout incidents should indicate whether this data is worldwide or only from the U.S. If this table only pertains to the U.S., it would be useful to provide a global perspective since drill rig operators operate worldwide.
26	2.2.1.2	2-7	The descriptions of the Alternative and the key on Figure 2-1 are not consistent and make it difficult to identify the areas of concern (i.e. the EPA, 100 miles of Florida coast, pinnacles, and topographic features.
27	2.3.1.2	2-14 thru 2-33	This section would benefit by being streamlined to strictly identify those features of the respective alternatives and by eliminating the impact analysis portions. Because much of the material appears to have been copied from the WPA to CPA summary section, there are incorrect references to Texas features in the CPA section. The sections need to be thoroughly reviewed so that they are specific to the area of concern. Some of the impact summaries do not summarize known impacts of the DWH as potential impacts of an accidental spill. Many of the acronyms used in this section have not been spelled out.
28	2.3.1.2	2-14 thru 2-15	Air Quality: To the extent that validated data and published reports are available, the known air emissions from DWH should be included with reference as to the types and volume of emissions and their dispersion as an example of worst case effects.
29	2.3.1.2 & 2.4.1.2	2-15 & 2-43	Coastal and Offshore Water: No conclusion is drawn about the effects of an accidental spill. Consider including a discussion of the effects of DWH incident.
30	2.3.1.2	2-16	Coastal Barrier Beaches and Associated Dunes: There is no discussion of the cumulative effects of oil and gas development and other activities on these beaches and dunes. The conclusion that off-shore crude oil spills would be less toxic could be discussed in the context of peer-reviewed science from the DWH incident..
31	2.3.12 & 2.4.1.2	2-17 & 2-45	Wetlands: There is no discussion of the impacts of the DWH on coastal wetlands. The analysis would benefit from a discussion on DWH affects on coastal wetlands to the extent that this information can be located.
32	2.3.12 & 2.4.1.2	2-20 thru 2-21 & 2-51 thru 2-53	The argument about the impacts to chemosynthetic and non-chemosynthetic deepwater benthic communities would be strengthened by stating some of the NTL 2009-G40 distance requirements explicitly and providing evidence that those distances are sufficient to protect these communities from the anticipated impacts.

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API 1 COMMENTS 33-42

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

33	2.3.12 & 2.4.1.2	2-22 & 2-53	Paragraph 1, Soft-Bottom Benthic Communities: The argument in the first paragraph would be strengthened by stating the actual area of soft bottom used by oil and gas and stating what percentage of the seafloor it occupies. The discussion that the impacts to benthic communities would be sublethal should be demonstrated by evidence from the DWH to the extent that such evidence is available.
34	2.3.12 & 2.4.1.2	2-25 & 2-57	Paragraph 1, Coastal and Marine Birds: This discussion would be strengthened if "significant" were defined in the context of the impacts to coastal and marine birds. Later in the paragraph, the discussion of significant adverse effects refers to a population level effect. It would be useful to the reader to discuss the size of the population for reference. It is unclear why effects to sea turtle populations are being discussed at the end of the first paragraph of this section (pg.2-25).
35	2.3.1.2	2-26 thru 2-27	Paragraph 1: It is unclear what information is being referred to in the first sentence and what mitigation analysis is being referred to in the second sentence. The cumulative effects of multiple small oil spills should be discussed.
36	2.3.12 and 2.4.1.2	pg. 2-33	No mammal or plant species are listed in the preceding section; however, in the 3rd line, the sentence refers to the "above mammal and plant species".
37	2.3.3.3 and 2.4.3.3	2-41 & 2-74	Paragraph 2: The paragraph discusses loss of revenues to the Federal Government and economic impacts to companies, but does not provide any scale of what the losses or impacts could be.
38	2.4.1.2	2-59	Paragraph 2: Fish Resources and EFH: It is unclear why the Flower Garden Banks National Marine Sanctuary is being referenced in this section. It is located in the WPA not CPA.
39	2.4.1.2	2-62	Paragraph 2, Recreational Resource: It is unclear why impacts to the coast of Texas are being discussed here when Texas borders the WPA.
40	3.1.1	3-3, 3-5, 3-12 & 3-18	Paragraph 1: There appears to be an inconsistency regarding the discussion of Eastern Planning Area (EPA) lease activities. The text indicates the EPA leases will be addressed in a separate EIS, however the Section 3.1.1.1.2 text and Table 3-4 (pg. Tables-15), include reference to future lease activities in the EPA being included in the projections. The data in Table 3-4 could include a footnote that EPA data for past and present activities are included but not projections for future EPA lease sales if that is indeed correct. The data in Tables 3-5 and 3-6 when combined equal the values presented in Table 3-4 in many instances.
41	3.1.1.5	3-27	The discussion in this section should also mention that some of the air pollutants emitted are greenhouse gases (GHGs).
42	3.1.1.6	3-28	The description of the noise generating surveys could be added to Section 3.1.1.2.1 to complete

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Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

API 1 COMMENTS 43-52

			the acoustic survey discussion and a reference back included. This would allow the reader to focus attention on the gun operation effects in the water column and on marine mammals that may be within the area of potential effect.
43	3.1.2.2.4	3-56	Abbreviations and Acronyms listed in the Table of Contents are incomplete. Add NORM and TWC. Also suggest adding additional acronyms found in the Socioeconomic sections.
44	3.2.1.5	3-60 – 3-63	This section could be strengthened by incorporating additional data obtained post spill DWH studies. Predictions by the models could be compared to those observed during and following the DWH incident.
45	3.2.2	3-76	Paragraph 3: This paragraph should be updated to reflect the most recent study on this subject. (McNutt, M, R. Camilli, G. Guthrie, P. Hsieh, V. Labson, B. Lehr, D. Maclay, A. Ratzel, and M. Sogge. 2011. Assessment of Flow Rate Estimates for the Deepwater Horizon / Macondo Well Oil Spill. Flow Rate Technical Group report to the National Incident Command, Interagency Solutions Group, March 10, 2011.)
46	3.3.2	3-86 – 3-88	Paragraph 1: A statement on the status of Alabama and Mississippi leasing activity and pipeline infrastructure should be included for completeness.
47	3.3.2	3-87	Pipeline Infrastructure: The sub headings Texas and Louisiana within the section are an unnecessary insertion. Use and updating of the CPA DEIS (BOEMRE 2011-027) text could be considered as a replacement.
48	3.3.3	3-88	Paragraph 6: First sentence states: "Natural and man-caused influencing factors occur in the offshore areas of Gulf States while OCS activity takes place at the same time." but the remaining portion of the section deals only with man-caused factors. Subsequent sections deal with natural factors (see Section 3.3.5). The inconsistency should be addressed.
49	3.3.3.1	3-89	Paragraphs 1 & 2: The discussion of the Gulf Coast ODMDS locations should be reviewed as sites are discussed in Mississippi and Louisiana with maps showing Texas and not Mississippi. Similarly, the Mobile District should be included when discussing the Mississippi sites rather than Galveston and New Orleans Districts.
50	3.3.3.6	3-93	Paragraph 1: The status of Gulf Gateway as an operating facility should be reviewed and updated as appropriate. A general review and update of the status of proposed and licensed deepwater ports would also be helpful.
51	3.3.3.6	3-93	Paragraph 2: The inclusion of a single onshore facility in an offshore context is out of place. If Golden Pass is to be discussed then the other onshore terminals should also be included.
52	3.3.3.6	3-93	Paragraph 3: The relationship between shale gas and LNG Liquefaction Terminals could be

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Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

API 1 COMMENTS 53-63

			better stated such that there is no confusion with the LNG Deepwater Ports, all of which were proposed as regasification only terminals.
53	3.3.3.6	3-93	Paragraph 4-7: General review and update of the status of deepwater ports and LNG liquefaction onshore would be helpful.
54	3.3.3.8	3-96	Renewable Energy Projects in Texas State Waters: General review and update of the status of the renewable energy projects would be helpful.
55	3.3.4	3-97	Paragraph 1: This section needs to include climate change issues relative to coastal water quality. Although Sea-level Rise (Section 3.3.4.1) addresses one element of climate change, it does not deal with changing surface water temperatures and the effects of this phenomenon.
56	3.3.4.2	3-99	Paragraph 3: The CWPPRA projects could be updated to reflect the newly released Louisiana Coastal Master Plan update: http://coastal.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&nid=150&pnid=0&pid=205&catid=0&elid=0
57	3.3.4.3	3-100	Paragraph 2: The last sentence appears out of place. It could be mentioned that the federal channels have jetties to keep them open and therefore interrupt regional sediment transport. These channels require routine maintenance and do experience significant scouring.
58	3.3.4.3	3-100	Paragraph 6: Suggest the words "and pipeline access canals" in the first sentence be deleted as private pipeline related material is not used in the USCAE Beneficial Use Program.
59	4.1.1.1	4-9	Paragraph 2: Third sentence should be corrected to state that BOEM expects the ambient concentration of pollutants due to emissions are expected to be well within the National Ambient Air Quality Standards. As currently written, the sentence implies the NAAQS are emission standards, which they are not.
60	4.1.1.1.1	4-9	The summary of potential impacts should also include a discussion for GHGs.
61	4.1.1.1.1	4-10	Paragraph 1: Fifth line, there is a missing "µ" for the 3-hour increment value for SO_2. The sentence should also list the 1-hour increment value for NO_2 recently issued by USEPA for analysis of 1-hour NO_2 impacts.
62	4.1.1.1.1	4-10	Paragraph 2: The size range listed for PM_{10} should be stated as "equal to or less than 10 µm diameter". PM_{10} includes all particles smaller than 10 microns diameter, including particles less than 2.5 microns diameter.
63	4.1.1.1.1	4-10	Paragraph 10: The first sentence should be revised to include wording indicating the annual NO_2 NAAQS was retained; as written it could be interpreted that the 1-hour NO_2 NAAQS replaced

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API 1 COMMENTS 64-70

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

			the annual NO_2 NAAQS.
64	4.1.1.1.1	4-10	Paragraph 10: The second sentence should be revised to indicate that in addition to the 1-hour SO_2 standard, EPA revoked the 24-hour and annual primary SO_2 NAAQS.
65	4.1.1.1.2	4-12	In order to better understand the quantity of emissions shown in Table 4-2 and to relate those emissions to level of development, this section should discuss the level of development activity in the Planning Area (e.g. number of wells developed per year) or refer to the appropriate section in the document where level of activity is discussed.
66	4.1.1.1.2	4-14	Paragraph 2: The second sentence should be corrected to state that the ambient concentrations of pollutants due to WPA emissions are expected to be well within the National Ambient Air Quality Standards. As currently written, the sentence implies the NAAQS are emission standards which they are not.
67	4.1.1.2.2.1	4-29	Paragraph 4: "As well, shelf waters **or** sediments off the coast of Louisiana contain variable concentrations of organic pollutants including polycyclic aromatic hydrocarbons (PAH's), herbicides such as Atrazine, chlorinated pesticides, and polychlorinated biphenyls (PCB's), and trace inorganic (metals) pollutants (Turner et al., 2003)." Should '**or**' be 'and' in this sentence?
68	4.1.1.4.2	4-62	Paragraph 1: "State requirements are expected to be enforced to prevent and correct such occurrences" Are the state requirements for Texas pertinent to the document? Should they be added after this statement to enhance the specifics of regulatory action that may be required for the lease sale area?
69	4.1.1.5.4	4-79	Cumulative Impact: Information on cumulative impacts to SAVs needs to be addressed more comprehensively. The overall role of coastal development and how nutrient inputs into the coastal regions affect SAVs is important to note relative to oil & gas development and impacts. Also, global warming effects on seagrasses should be included in this assessment (see http://www.ucsusa.org/gulf/gcplaceslag.html). Similarly, USGS has published information at http://www.usgcrp.gov/usgcrp/Library/nationalassessment/gulfcoast/gulfcoast-chapter6.pdf. A good reference for this issue is - Short, F.T. and Neckles, H. 1999. The effects of global climate change on seagrasses. Aquatic Botany 63: 169-196.
70	4.1.1.6.1	4-82	Paragraph 3: Although the DEIS provides a link to Biological Stipulation Map Package, which contains a subsequent link that provides figures of No Activity Zones around topographic features, as a public document this information cannot be accessed in hard copy versions. It would be helpful to provide more information of this issue in the DEIS, or provide maps showing No Activity Zones as provided in the link.

API 1 COMMENTS 71-80

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

71	4.1.1.11.2	4-185	Paragraph 2: Last sentence has a double period at the end.
72	4.1.1.11.2	4-196	Vessel and Operation Noise: The expected noise levels in dB at various distances that would be expected from vessel and platform operations should be included in the discussion to give the reader an idea of the noise levels that may be generated by these activities.
73	4.1.1.11.2	4-197	Drilling and Production Noise: The expected noise levels in dB at various distances that would be expected from drilling and production operations should be included in the discussion to give the reader an idea of the noise levels that may be generated by these activities.
74	4.1.1.11.2	4-206	Paragraph 3: Typographical error Chapter 4.1.11.3 should replace Chapter 41.1…
75	4.1.1.12.4	4-247	Seagrass losses in the GOM indirectly affect sea turtles. Impacts to seagrasses are a result of coastal development and nutrient loading. This connection needs to be made during cumulative impacts discussions on sea turtles. See other comments related to cumulative impact evaluation and seagrasses.
76	4.1.1.11.4 and 4.2.1.12.4	4-213 & 4-720	Paragraph 4: Authors may want to align the statements in the Summary and Conclusions of Sections 4.1.1.11.4 and 4.1.1.12.4 to make clear that a decision can be made with the recognition that there is incomplete or unavailable information
77	4.1.1.17.4	4-341	Paragraph 1: Redundant phrase in first sentence: "The cumulative impacts to recreational fishing activity from a WPA proposed action will arise from a WPA proposed action, the existing OCS Program, and the expected progression of the recreational fishing industry in the Gulf of Mexico."
78	4.2.1.1.1	4-441	Paragraph 5: After the General Conformity heading (same statement in section 4.1.1.1.4 page 4-18 third paragraph under Cumulative Impacts): There are modeling tools available to assess the transport of pollutants in offshore areas such as the OCD model, or more recently an updated version of the CALPUFF model that incorporates overwater modeling capability
79	4.2.1.5.1	4-522	Paragraph 5: The statement regarding the resiliency of SAV is dervived from a *Ruppia maritima* study related to storm events in Grand Bay located on the Mississippi/Alabama border in a highly sheltered area. Effects from storm events could prove to be different from an oil spill. Although "resiliency could prove be important for SAVs" can the same assumption be applied to different species such as *Halodule beaudettei*. Can the assumption that resiliency from a storm apply to impacts such as oil spills? Is there a reference to validate this statement? Can the statement be reworded or removed so these implications are not made?
80	4.2.1.6.1.1	4-535	Paragraph 4: the paragraph discusses 2 hydrocarbon concentrations from 2 depths. It seems odd

API 1 COMMENTS 81-88

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

			that only two samples were collected. If these were means of multiple samples the DEIS needs to state this and the concentration range(s) for the samples collected. Since this information is being used to support a position that concentrations were not high enough (e.g., >1.0 ppm) to cause chronic or short-term impacts to corals, the public should understand that the preponderance of data collected exhibited concentrations below 1 ppm. If, only two samples were collected, this would suggest much uncertainty in the conclusions expressed in the DEIS regarding impacts to corals from the DWH event.
81	4.2.1.12.2	4-702	Section Heading incorrect 4.2.1.12.2 replaces 4.1.1… The Table of Contents would also need to be updated.
82	4.2.1.12.2	4-703	Vessel and Operation Noise: The expected noise levels in dB at various distances that would be expected from vessel and platform operations should be included in the discussion to give the reader an idea of the noise levels that may be generated by these activities.
83	4.2.1.12.2	4-704	Drilling and Production Noise: The expected noise levels in dB at various distances that would be expected from drilling and production operations should be included in the discussion to give the reader an idea of the noise levels that may be generated by these activities.
84	4.2.1.12.2	4-707	Paragraph 3: Please provide an update on the status of the IHA application (FR34567) to NMFS. A brief overview indicating BOEM's estimate of potential take due to the proposed Oil and Gas Activities would be informative as well as NMFS progress on the review. This comment is applicable to page 4-199 also.
85	4.2.1.12.4	4-720	Paragraph 3: Typographical error in last sentence on page contains an extra period.
86	4.2.1.17	4-816	Paragraph 5: Conflicting statements on Gulf Sturgeon studies appear within this paragraph and should be resolved.
87	4.2.1.17.1	4-822	Paragraph 2: Under the heading "Threats to Gulf Sturgeon": The sentence "Poor water quality because of….may be affecting sturgeon populations" has no reference or data associated with the statement. Is there a reference or data to add to strengthen or validate the statement?
88	4.2.1.23.2.1	4-937	Paragraph 2 : While the proposed project life of a CPA action is 40-years, simply describing population trend differences between years 1960 and 2008 is not as informative to the reader as would focusing on those trends of population changes during years that included major impacts (i.e. regulatory policy changes, drilling booms, DWH, moratoriums, hurricanes, national economic recessions, etc). For a general comparison, incremental effects relating these

Comment Matrix

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API 1 COMMENTS 89-95

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

			disturbances to regional economic swings might reveal more informative and pertinent trends especially to those Parishes and Counties where minorities reside.
89	4.2.1.23.2.2	4-939	Paragraph 3. Race and Ethnic Composition: It might be helpful to know the geo-racial composition of the OCS workforce as this would display a focused projection of individuals that may directly be affected by oil and gas lease sale and subsequent permitting decisions..
90	4.2.1.23.3.1	4-942	Paragraph 1, Line 11, place "within" between "sales" and "the" …analyze sales within the CPA and …
91	4.2.1.23.2.1	4-937	Paragraph 3: The concluding sentence in the second paragraph of this section needs to be stated directly - suggest breaking up these concluding remarks into two distinct sentences Current Sentence: "A CPA proposed lease sale is projected to have a greater employment impact for economic impact areas (EIA's) in both the CPA and WPA; however, for a WPA proposed lease sale, slightly more than half of employment is generated in TX-3 (which includes Houston) and, for a CPA proposed lease sale, about half of the employment is also generated in TX-3." Also, if possible, it would be helpful to present the EIA, labor market areas (LMA), WPA & CPA relationships depicted in Table 4-34 in a customized Map reflecting employment impacts (spatial and scale) resulting from WPA and CPA leasing changes.
92	4.2.1.23.3.1	4-943	Paragraph 2: When describing the direct spending and employment (jobs) in the Gulf region, it would be helpful to know what percentage this is of the regional (and national) economies.
93	4.2.1.23.3.1	4-943	Paragraph 2: How would the loss of oil and gas supply affect the cost of energy as a whole? If the OCS program were to diminish or even disappear, what substitute activity would the regional populous rely on? On a broader note… What would be the effects of a rejection of future OCS lease sales (the No Action alternative) on the oil and gas exploration and production industry? Would a rejection of OCS leases have a greater negative effect than the positive effect of opening up new leases?
94	Table 4-51	Tables-134	Why aren't there aggregated numbers for all EIA's presented in the Table? The title should be consistent with documentation and read "Baseline Employment Projections (in thousands) by EIA, 2010 – 2051.
95	4.2.1.23.3	4-944	Deepwater Horizon Event: In addition to describing costs related to the DWH event, there should be a section devoted to describing costs associated with or factor such as new policy changes, new regulations and requirements in the application process, enhanced inspection procedures, newly established spill funds, insurance, and taxes. These costs should be identified and quantified to the extent possible.

Comment Matrix

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API 1 COMMENTS 96-103

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

96	4.2.1.23.3.2	4-945	Paragraph 1, Introduction: Sentence that refers to IMPLAN is not clear to readers, maybe should state that MAGPLAN uses IMPLAN multipliers to estimate the ripple effects (economic output, employment, income, and other economic effects) that occur throughout the economy resulting from the new or re-investment spending activities. Also, anticipated employment (Jobs) may be categorized as "Saved versus Created".
97	4.2.1.23.3.2	4-945	Paragraph 1: Was the National economic recession factored into the MAG-PLAN analysis? Were the overall impacts from the DWH incident segregated from National/Regional economic influences?
98	4.2.1.23.3.2	4-945	Paragraph 1: The statement should include something about loss of these jobs and the impact it would have on the regional economy and specific local economies highly dependent on these jobs.
99	4.2.1.23.3.2	4-946	Paragraph 1: Routine Events Conclusion seems to assume a favorable lease sale decision. Conversely, a discussion should be included that focuses on the magnitude of detrimental effects to employment and income within the local, regional, and national economy, given the proposed OCS lease sales where denied.
100	4.2.1.23.3.4	4-947 4-948	Paragraph 2, Projected Employment: Much of this section is redundant to information provided on page 4-945.
101	4.2.1.23.3.4	4-948	Paragraph 2: This would be a good location for a general analysis of past, present, and foreseeable future permit actions and their broad effects on economy. Also, since the OCS program is driven by current administrative policies, this would be a good location to cite those policies. Also, the last sentence is missing a word – expected "to" have minor…
102	4.2.1.23.4	4-948	Paragraph 3: In 1997, EJ was expanded to include EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 1997) which requires a similar analysis for children. Federal agencies are required to identify and address environmental health risks and safety risks of its actions that may disproportionately affect children. Consider revising this section to address EO 1305.
103	4.2.1.23.4.1	4-949	Paragraph 1: Need to specifically state "The counties/parishes with more than five facilities were selected for review", and then list those counties/parishes. Sentence is missing words " The BOEM focuses on counties/parishes and census tracts with high or medium concentration of OCS-related infrastructure and defines minority populations as those counties/parishes with a higher percentage of their population that is "**classified as**" minority relative to their respective State averages.

API 1 COMMENTS 104-111

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

104	4.2.1.23.4.1	4-950	Paragraph 1: "Thirteen counties/parishes are considered to have a medium concentration (16 – 49 facilities) of oil-related infrastructure" - needs a location point of reference - Louisiana or GOM Planning Areas? Statement in same paragraph describing overall population declines relating to Hurricane Katrina and the Recession needs to be placed in separate population section. This section would benefit from additional organization and elimination of redundancy.
105	4.2.1.23.4.2	4-953 4-954 4-955	Proposed Action Analysis on EJ: This section contains many informative topics; however if not already described, the paragraphs describing fabrication/shipyard, material moving, highway corridors, landfill capacities, are too detailed and belong in another section. Locations of these facilities are only relevant to EJ if they are located in poor or minority area, or hire low income or minority workers. In any event, this conclusion could be simplified without reiterating the overall OCS support system.
106	4.2.1.23.4.2	4-953 4-954 4-955	Clarify whether IMPLAN is presenting a regional or local view. If IMPLAN is only looking at regional impacts, then it may be overlooking the local impacts, say to a Port Fourchon and impacts to communities, that are minority/low income based and that rely heavily on the oil and gas exploration and production business and support companies.
107	4.2.1.23.4.2	4-955	Paragraph 4: Suggest rewording sentence. "Similarly, impacts related to a CPA proposed action are expected to be economic and to have a limited but positive effect on low-income and minority populations because it will sustain current industry and fully utilize related support systems."
108	4.2.1.23.4.3	4-955	Paragraph 5: Accidental events should have already been described in subsequent sections. This section should focus on EJ and children population risks and focus less on describing what an accidental event is or could be.
109	4.2.1.23.4.4	4-962	Paragraph 3, OCS: Says appropriate mitigating measures would be enforced by the responsible political entities. List examples of the political entities. Are they federal state and local agencies?
110	Table 4-1	Tables-49	The row for Sulfur Dioxide should be updated to reflect revised SO_2 NAAQS. The Annual and 24-hour standards were officially revoked in June 2010 when the 1-Hour SO_2 NAAQS took effect. However, the 24-hour and Annual NAAQS remain in effect until one year after an area is designated for the 2010 SO_2 standards.
111	Table 4-2	Tables-50	SO_2 value for Exploration/Delineation is incorrect; there is a "-"missing between 105 and 157. Also, the pairs of values shown in some cases are not shown as "low – high" but are shown as "high – low"; see NO_2 for Support Vessels as an example.

API 1 COMMENTS 112-113

Enclosure 1 - Comments on the 2012-2017 GOM Multisale DEIS

112	Table 4-2	Tables-50	It would be helpful to segment Table 4-2 into emissions associated only with construction and only with operation. For example, it is unclear if "Support Vessels" emissions are from construction, operation, or a combination of both.
113	Appendix B, Sect 6	B-50	Considering the subject of this appendix (Catastrophic Spill Event Analysis), the cumulative assessment section for impacts to environmental and socioeconomics is very short and vague. With all of the issues surrounding the subject (and as addressed throughout this analysis), it is recommended that BOEM provide a more in-depth analysis of how all factors can affect the environmental and socioeconomic conditions found throughout the GOM.

API ENCLOSURE 2 (API 2) COMMENTS 1-2

Detailed Technical Comments Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; WPA Lease Sales 229, 233, 238, 246, and 248; CPA Lease Sales 227, 231, 235, 241, and 247; Draft Environmental Impact Statement ("DEIS")

General Statements

Analysis:

1. The DEIS suggests that "very few scientific results have been published as of this writing" and that "the impacts of the oil spill are not yet known." *See* DEIS 4-123

   - The statement "very few scientific results" and others like it elsewhere in the report should be removed because much of the chemistry data from response-phase sampling (*e.g.*, OSAT, JAG and BP data) is readily available online.
   - **References:**
     - Operational Science Advisory Team (OSAT), 2010, Summary report for sub-sea and sub-surface oil and dispersant detection: Sampling and monitoring, Unified Area Command, New Orleans, LA, Released on December 17, 2010.
     - OSAT-2 (Operational Science Advisory Team), 2011, Summary Report for Fate and Effects of Remnant Oil in the Beach Environment, prepared by Operational Science Advisory Team Gulf Coast Incident Management Team for Lincoln D. Stroh, CAPT, U.S. Coast Guard, Federal On-Scene Coordinator, Deepwater Horizon MC252, Feb 10.
     - Joint Analysis Group, 2010a, Review of R/V Brooks McCall data to examine subsurface oil. Internet website: http://www.noaa.gov/sciencemissions/PDFs/JAG_Report_1_BrooksMcCall_Final_June20.pdf.
     - Joint Analysis Group (JAG), 2010b, Review of Preliminary Data to Examine Oxygen Levels In the Vicinity of MC252#1 May 8 to August 9, 2010. August 16.
     - Joint Analysis Group (JAG), 2010c, Review of Preliminary Data to Examine Subsurface Oil In the Vicinity of MC252#1 May 19 to June 19, 2010. July 20.
     - BP website, Monitoring and sampling information; Technical reports and documentation, Last accessed January 30, 2012, Available at: http://usresponse.bp.com/go/doctype/2911/76999/_and http://www.bp.com/sectiongenericarticle800.do?categoryId=9036592&contentId=7067598.
   - The statement "the impacts of the spill are not yet known" should be revised to note that significant data is available regarding potential impacts.

2. The DEIS relies in numerous places on Adcroft et al. 2010. *See, e.g.*, DEIS 3-104; 4-97; 4-123; 4-124; 4-133; 4-137; 4-146; 4-149; 4-156; 4-158; 4-160; 4-171.

Enclosure 2, *Detailed Technical Comments on 2012-2017 GOM Multisale DEIS*

API 2 COMMENTS 2-3

   - However, since Adcroft relies on simulations and not sampling data, the EIS should also cite deep sea monitoring data collected by BP, NOAA, and others reported online, or in papers and presentations by OSAT, Hazen, Lee and Boehm.
   - **References:**
     - BP website, Monitoring and sampling information; Technical reports and documentation, Last accessed January 30, 2012, Available at: http://usresponse.bp.com/go/doctype/2911/76999/_and http://www.bp.com/sectiongenericarticle800.do?categoryId=9036592&contentId=7067598.
     - NOAA website, NOAA Science Missions & Data: Deepwater Horizon/BP Oil Spill, Last accessed: January 30, 2012, Available at: http://www.noaa.gov/sciencemissions/bpoilspill.html.
     - Operational Science Advisory Team (OSAT), 2010, Summary report for sub-sea and sub-surface oil and dispersant detection: Sampling and monitoring, Unified Area Command, New Orleans, LA, Released on December 17, 2010.
     - Hazen, T. C., et al., 2010, Deep-Sea Oil Plume Enriches Indigenous Oil-Degrading Bacteria, Science 330:204-208.
     - Lee, Kenneth, et al. 2011. Time-series Monitoring the Subsurface Oil Plume released from Deepwater Horizon MC252 in the Gulf of Mexico. International Oil Spill Conference, May 23-26, Portland, Oregon, USA.
     - Boehm, P. D., et al., 2011, Aromatic Hydrocarbon Concentrations in Seawater: Deepwater Horizon Oil Spill, International Oil Spill Conference, May 23-26, Portland, Oregon, USA.
     - Boehm, P. D., et al., 2011, Distribution and Fate of PAH and Chemical Dispersants in the Water Column Following the Deepwater Horizon Oil Spill, SETAC North America 32nd Annual Meeting, November 13-17, Boston, Massachusetts, USA.).
     - Atlas, R. M. and T. C. Hazen. 2011. Oil Biodegradation and Bioremediation: A Tale of the Two Worst Spills in U.S. History, Environ. Sci. Technol. 45(16):6709-6715.

3. In various places, the DEIS states or implies that the presence of fluorescence in the water column indicates the presence of oil. *See, e.g.*, DEIS 3-71; 4-22; 4-30; 4-452; 4-463.

   - It is more accurate to say that the presence of fluorescence in the water column may indicate the presence of petroleum hydrocarbons or other substances. This clarification should be made throughout the EIS.

Resources

Air

API 2 COMMENT 4

Analysis:

4. The DEIS states, "During the DWH event, a huge number of air samples were collected. Analyses included BETX, PM, H2S, NAAQS criteria pollutants, and dioxin. According to USEPA, in coastal communities air pollutants from the DWH event were at levels well below those that would cause short-term health problems. The air monitoring conducted to date has not found any pollutants at levels expected to cause long-term harm. However, questions have been raised concerning the effects of the DWH event on public health and the workers, resulting from the releases of particles and toxic chemicals due to evaporation from oil spill, flaring, oil burn, and the applications of dispersants; see also **Chapter 4.2.1.23.4**. Air quality impacts include the emission of pollutants from the oil and the fire emissions that are hazardous to human health and that can possibly be fatal." *See* DEIS 2-43; *see also* DEIS 4-447; 4-949.

- This statement's reference to "BETX" should read "BTEX."
- USEPA monitoring data has so far shown that the use of dispersants during the DWH event did not result in the presence of chemicals that surpassed human health benchmarks.
- This passage should be revised to note that exceedances of the OSHA Occupational Permissible Exposure Limits (PELs) and the more stringent American Conference of Governmental Industrial Hygienists (ACGISH) Threshold Limit Values (TLVs) were extremely rare throughout the response, with only isolated exceedances of any occupational exposure guideline, and many exposures at non-detectable levels. For example, of the over 28,300 personal benzene samples taken by BP as of September 30, 2011, only one exceeded the OSHA PEL and only seven exceeded the TLV, while 27,651 contained no or non-detectable concentrations of benzene. (OSHA, NIOSH, BP data).
- Following the statement that "air monitoring conducted to date has not found any pollutants at levels expected to cause long-term harm," a sentence detailing recent studies should be added: "In particular, recent studies of air quality impacts from the DWH event have found that benzene and other more water soluble volatile oil compounds were either not present, or present at very low concentrations, in the air during the response." (Avens et al. 2011; Middlebrook et al. 2011).
- Although "questions have been raised concerning the effects of the DWH event on public health and the workers," more recent assessments of worker health performed by NIOSH and OSHA have found that exposure levels are generally below occupational exposure limits. (Rotkin-Ellman et al. 2010, OSHA, NIOSH).

Enclosure 2, *Detailed Technical Comments on 2012-2017 GOM Multisale DEIS*

API 2 COMMENTS 4-5

- The general statement that "Air quality impacts. . . can possibly be fatal" should be modified to avoid the suggestion that air quality impacts specifically from the DWH spill were possibly fatal. Instead, it should be noted that air monitoring during the DWH spill did not identify pollutant levels expected to cause long-term harm.
- **References:**

  - USEPA website, Human Health Benchmarks for Chemicals in Water, Last accessed January 30, 2012, Available at: http://www.epa.gov/bpspill/health-benchmarks.html.
  - OSHA, 2011, OSHA's Efforts to Protect Workers. http://www.osha.gov/oilspills/index.html.
  - OSHA, 2010, OSHA Statement on 2-Butoxyethanol & Worker Exposure, July, Last accessed on January 30, 2012, Available at http://www.osha.gov/oilspills/oilspill-statement.html.
  - NIOSH, 2011, Deepwater Horizon Response: NIOSH Health Hazard Evaluation. http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html.
  - BP, 2011. Personal Exposure Monitoring Results Summary. 3Q 2011. http://usresponse.bp.com/external/content/document/2911/1215835/1/Personal%20Exposure%20Monitoring%20Results%20Summary%20as%20of%203Q%202011-2.pdf.
  - Avens, et al., 2011, Analysis and Modeling of Airborne BTEX Concentrations from the Deepwater Horizon Oil Spill, Environmental Science & Technology, 45:7372-7379.
  - Middlebrook, et al., 2011, Air quality implications of the *Deepwater Horizon* oil spill, PNAS, 10.1073/pnas.1110052108.
  - Rotkin-Ellman, M., K.M. Navarro, and G.M. Solomon. 2010. Gulf oil spill air quality monitoring: Lessons learned to improve emergency response. Environ. Sci. Technol. 44(22):8365–8366.

5. The DEIS states, "Following the DWH event, USEPA provided the TAGA bus, a mobile laboratory, to perform instantaneous analysis of air in coastal communities. Two ingredients in the *Corexit* dispersant were measured. Very low levels of dispersants were identified. Due to the distance to shore and an assumed accidental spill size of 2,200 bbl, it is unlikely that dispersants would be carried to onshore areas." *See* DEIS 4-16.

- It is incorrect to state that any level of dispersants was identified onshore. EPA has noted that the *Corexit* ingredients that were monitored also are common ingredients in a number of household products. Therefore, detection of any of these ingredients onshore does not equate to the detection of dispersants.

API 2 COMMENTS 5-7

- Moreover, not only was it "unlikely that dispersants would be carried to onshore areas," EPA found that there is no evidence that dispersant application resulted in a significant impact in onshore air quality
- Also note that while two dispersant ingredients were sampled in air, one of the ingredients, 2-butoxyethanol, was only present in *Corexit* 9527.
- **References:**
  - USEPA website, Mobile Air Monitoring on the Gulf Coast: TAGA Buses, Last accessed January 30, 2012, Available at: http://www.epa.gov/bpspill/taga.html.

6. The DEIS states, "McGrattan et al. (1995) modeled smoke plumes associated with in-situ burning. The results showed that the surface concentrations of particulate matter did not exceed the health criterion (at that time) of150 µg/m3 beyond about 5 km (3 mi) downwind of an in-situ burn." *See* DEIS 4-15.

   - Since the current PM_{10} ambient air quality standard is still 150 $\mu g/m^3$ in 24 hours, the statements should be revised by removing the phrase "(at the time)" and adding PM_{10} as the type of particulate matter measured.

7. The DEIS states, "Measurements of dioxins and furans during the DWH event in-situ burning were made (Aurell and Gullett, 2010). The estimated levels of dioxins and furans produced by the in-situ burns were similar to those from residential woodstove fires and slightly lower than those from forest fires, according to USEPA researchers (Schaum et al., 2010) and roughly 25-65 times higher than those observed for controlled combustion of waste engine oil, within the range of PCDD/PCDF emission factors determined for open biomass burning, and over 2 orders of magnitude lower than open burning of residential waste (Aurell and Gullet, 2010) and, thus, concerns about eventual dioxin bioaccumulation in seafood were alleviated. The results obtained from the air quality modeling and the use of a screening level assessment also indicate that the cancer risks due to the dioxin emissions from in-situ burns of the Gulf oil spill do not exceed the USEPA cancer risk management guidelines of 1 in 10-6 (Schaum et al., 2010). The shoreline dioxin concentration from the in-situ burns would be much less than the measured air concentration in rural locations of the U.S. and, thus, concerns about bioaccumulation in seafood were alleviated." *See* DEIS 4-446.

   - The sentence beginning "Measurements of dioxins" should be revised to clarify that these measurements were not taken at locations where workers or the public were exposed, but rather within smoke plumes far offshore and at altitude.
   - The sentence beginning "The results obtained from. . ." should be revised to clarify that these results were between 2 to 6 orders of magnitude below the EPA guidelines of 10^{-6}. ("The lifetime incremental cancer risks were estimated as 6×10^{-8} for inhalation by workers, 6×10^{-12} for inhalation by onshore residents and 6×10^{-8} for fish consumption by residents." Schaum et al. 2010).
   - **References:**

API 2 COMMENTS 8-10

  - Schaum, J., M. Cohen, S. Perry, R. Artz, R. Draxler, J.B. Frithsen, D. Heist, M. Lorber, and L. Phillips. 2010. Screening level assessment of risks due to dioxin emissions from burning oil from the BP Deepwater Horizon Gulf of Mexico spill. 21 pp. Internet website: http://www.epa.gov/research/dioxin/docs/OilScreen25.pdf. Also available as: Environ. Sci. Technol. 44(24):9383-9389.

8. The DEIS states, "Organic aerosols formed downwind from the DWH oil spill (de Gouw et al., 2010), during which the lightest compounds in the oil from the DWH blowout evaporated within hours and during which the heavier compounds took longer to evaporate, contributing to the formation of air pollution particles downwind." *See* DEIS B-5.

   - It should be clarified that the formation of organic aerosols was associated with evaporation of "heavier compounds" and the evaporation of the "lightest compounds" refers to the VOCs.
   - This statement should cite to the following references that estimate potential impacts from the DWH event:
     - Ryerson, T. B., et al., 2011, Atmospheric emissions from the Deepwater Horizon spill constrain air water partitioning, hydrocarbon fate, and leak rate, Geophysical Research Letters 38:L07803.
     - Middlebrook, et al., 2011, Air quality implications of the *Deepwater Horizon* oil spill, PNAS, 10.1073/pnas.1110052108.

9. The DEIS states, "During the DWH event, air samples collected by BP, OSHA, and USCG near shore showed levels of benzene, toluene, ethylbenzene, and xylene that were mostly under detection levels. Among the 15,000 samples taken by BP, there was only one sample where benzene exceeded the OSHA Occupational permissible exposure limits." *See* DEIS B-31.

   - This statement should be updated to reflect that over 28,000 personal benzene samples have been taken by BP as of September 30, 2011 and only one sample exceeded the OSHA permissible exposure limits.
   - **References:**
     - BP, 2011. Personal Exposure Monitoring Results Summary. 3Q 2011. http://usresponse.bp.com/external/content/document/2911/1215835/1/Personal%20Exposure%20Monitoring%20Results%20Summary%20as%20of%203Q%202011-2.pdf.

Archaeological Resources

10. The DEIS states, "Although information on the actual impacts from the DWH event are inconclusive at this time, it is expected that impacts on prehistoric archaeological sites have occurred through hydrocarbon contamination of organic materials, which have the potential to date site occupation through radio carbon-dating techniques, as

API 2 COMMENTS 10-13

well as possible physical disturbance associated with spill cleanup operations." *See* DEIS 4-902.

- This statement should be clarified to state whether there is a scientific basis for this expectation, or whether this expectation is speculative. If the expectation is speculative, then the phrase "it is expected that" should be replaced with "it is possible that."

11. The DEIS states, "The potential effects of chemical dispersants on microbes hastening the disintegration of shipwrecks are unknown. While the Macondo well is located in the CPA, the impacts from the DWH event may be used as an analogy for activities that are planned in the WPA. It is known that there are at least seven historically significant archaeological resources within 20 mi (32 km) of the Macondo wellhead." *See* DEIS 4-358.

- The statement should be clarified to distinguish between direct effects of dispersants on microbes and indirect effects of dispersants on microbes through, for example, changes in oil particle size distribution.
- An additional sentence should be added to note that the concentrations of dispersant in the subsea were estimated to be extremely low (*i.e.* 10-100 ug/L at ~1-10 km from the flowing MC252 wellhead). (Kujawinksi, et al., 2011)
- **References:**
    - Kujawinski, E.B., M.C. Kido Soule, D.L. Valentine, A.K. Boysen, K. Longnecker, and M.C. Redmond. 2011. Fate of dispersants associated with the Deepwater Horizon oil spill. Environmental Science & Technology. 45: 1298-1306.

Birds

12. The DEIS repeatedly cites USDOI, FWS, 2010a, a source that contains data from December 14, 2010. *See, e.g.*, DEIS 4-257; 4-263 to 4-266; 4-268; 4-283.

- More recent information (May 12, 2011) is available at http://www.fws.gov/home/dhoilspill/pdfs/Bird%20Data%20Species%20Spreadsheet%2005122011.pdf.

13. The DEIS states, "it is unknown what the long-term impacts are to [avian] species and their populations at this time." DEIS 4-269.

- Preliminary findings and risk estimates relevant to potential long-term impacts have been reported in several studies of the impacts of the DWH event. These should be incorporated into the discussion. In addition, long-term toxicity studies of birds exposed to oil and components of oil prior to the DWH event have been conducted (*see, e.g.*, Stubblefield et al. (1995); Coon and Dieter (1981); Patton and Dieter (1980); Szaro et al. (1978)). Although the results of these studies are not directly comparable to the DWH event, they provide information for understanding

API 2 COMMENTS 13-14

how sublethal exposure to oil may have affected birds. These studies should also be included to provide less speculative, more concrete statements in the DEIS.

- **References:**
    - B. E. Finch et al., Embryotoxicity of weathered crude oil from the Gulf of Mexico in mallard ducks (Anas platyrhynchos), 30 Environmental Toxicology and Chemistry 1885, 1885–1891 (2011).
    - B. Furfey et al., Nesting Productivity of Black Skimmers in Coastal Louisiana Following the BP oil spill, Presentation, The Waterbird Society 35th Annual Meeting (Nov. 12, 2011).
    - J.R. Wakefield et al., Nearshore Avian Densities in the Northern Gulf of Mexico: Changes from May 2010 to May 2011, SETAC North America 32nd Annual Meeting (Nov. 13-17, 2011).
        - Reported the results of pre- and post-spill avian surveys in May 2010 and May 2011. Helicopter-based bird counts and photo documentation of almost all major colonial water bird breeding colonies were taken along all coastal beaches, barrier islands, major bays, and marshes located between Venice, Louisiana and Pensacola, Florida. Preliminary findings indicate that overall average density of all birds remained fairly consistent between 2010 and 2011.
    - Wakefield, J., Reilly, P., Swindell, W, Hansen, A., Bass, A., Clare, A., Deepwater Horizon Data Collection: Telemetry Data for Use in Evaluating Acute Avian Mortality, SETAC Special Session, (April 28, 2011).
        - Six hundred sixty-five birds of six species were tagged and tracked: great egret, brown pelican, black skimmer, clapper rail, seaside sparrow, and American oystercatcher. Some birds were unoiled and others were described as having trace or light oiling at the time of capture. Preliminary analyses indicate that for most species, the survival rates of trace and lightly oiled birds were comparable to the survival rates of birds in reference areas.
    - W. A. Stubblefield et al., Effects of Naturally Weathered Exxon Valdez Crude Oil on Mallard Reproduction, 14 Environmental Toxicology and Chemistry 1951 (1995).
    - N. C. Coon & Michael P. Dieter, Responses of Adult Mallard Ducks to Ingested South Louisiana Crude Oil, 24 Environmental Research 309 (1981).
    - J. F. Patton & Michael P. Dieter, Effects of Petroleum Hydrocarbons on Hepatic Function In the Duck, 65C Comp. Biochem. Physiol. 33 (1980).
    - R. C. Szaro et al., Effects of Chronic Indigestion of South Louisiana Crude Oil on Mallard Ducklings, 17 Environmental Research 426 (1978).

14. The DEIS states that "there remains the potential for long-term, sublethal effects of oiling from the DWH event on brown pelican populations and the potential adverse

API 2 COMMENTS 14-16

impacts to their continued recovery in the northern Gulf of Mexico." *See* DEIS 4-266; *see also* DEIS 4-784.

- It should be noted that the results of an NRDA telemetry study of brown pelicans with light and trace oiling shows that the survival rates of trace and lightly oiled brown pelicans over a period of months were similar to the survival rates of birds in reference areas.
- **References:**
  - Wakefield, J., Reilly, P., Swindell, W, Hansen, A., Bass, A., Clare, A., Deepwater Horizon Data Collection: Telemetry Data for Use in Evaluating Acute Avian Mortality, SETAC Special Session, (April 28, 2011).

15. The DEIS states that "cleanup and monitoring efforts related to the DWH event likely dramatically reduced reproductive success for numerous species using coastal, island, beach, and marsh habitats due to the large number of personnel, aircraft, boats, ATV's, etc. and the temporal overlap of these efforts with peak nesting." *See* DEIS 4-282; *see also* DEIS 4-802; 4-816.

- The basis for the statement that response activities "likely dramatically" reduced avian reproductive success should be cited. If this statement is based on speculation, the phrase "likely dramatically" should be replaced with "may have."
- The statement should also note that wildlife experts have been extensively involved in DWH response activities for the purpose of minimizing response impacts to wildlife and habitat.

16. Table 4-14 includes the least tern as a federally listed avian species and indicates that 111 least terns were collected following the DWH event. Similarly, the DEIS states that, "Of the federally listed avian species, the least tern appeared to be the most severely impacted from the DWH event." *See* DEIS 4-774; *see also* DEIS 4-782.

- These statements are incorrect in that only the interior population, not the coastal population, of the least tern is federally listed. Therefore, the least tern reference should be removed from Table 4-14.
- It should also be noted that a fact sheet published by the U.S. Fish and Wildlife Service indicates that this population would suffer spill impacts "in extreme conditions (*i.e.*, oil is pushed into rivers or marshes due to a hurricane)." U.S. Fish and Wildlife Service, Federally Listed Wildlife and Plants Threatened by Gulf Oil Spill (June 2010), *available at* http://www.fws.gov/home/dhoilspill/pdfs/FedListedBirdsGulf.pdf. These conditions did not occur, and there is no reason to believe that the least terns collected following the spill were part of the interior population.
- These and other discussions should be revised to clarify that although brown pelicans are included as a "federally listed species," they were delisted in November 2009. These and other discussions should note that only one un-oiled piping plover was collected following the spill. In short, the text should clarify

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API 2 COMMENTS 16-20

that there have been no confirmed impacts to any avian species currently federally listed as threatened or endangered.

17. The DEIS notes "For purposes of this EIS, applied to each category of birds described below in this chapter, BOEM has assumed that all birds collected may have been as a result of the DWH event and notes that these numbers tend to underestimate the total number of birds that may have died as a result of the event." *See* DEIS 4-773.

- It should be noted that many of the birds collected constitute background mortalities, *i.e.*, were not impacted by the spill, and that some avian carcasses were collected before oil reached the shoreline.
- It also should be noted that some carcasses were collected on the Atlantic Coast of Florida, an area that was not directly impacted by the spill.

18. Similarly, the DEIS lists the "five most impacted" species of shorebird based on the raw numbers of avian collections following the spill. *See* DEIS 4-776.

- It should be noted that these raw numbers do not necessarily reflect spill impact, as many of the carcasses collected reflect background mortality, and high numbers may reflect a mortality event caused by factors unrelated to the spill (*e.g.*, disease).

19. The DEIS states, "The DWH event and associated spilled oil that made it into the nearshore and coastal environment resulted in the loss of ~8,000 birds." *See* DEIS 4-816.

- As the DEIS elsewhere acknowledges (*see*, *e.g.*, DEIS Table 4-8, fn. b), some of these birds represent background mortality, and it is incorrect to say that all of them "resulted" from the DWH event. In addition, not all of the birds included in this figure represent mortalities; many of these are live birds, many of which were rehabilitated and released.

20. The DEIS contains a discussion of the detection rate for avian carcasses, *i.e.*, the numerical relationship between the number of birds collected and the number impacted. DEIS B-33.

- This discussion should be expanded to discuss A.E. Burger's observation: "The data show the wide variance in mortality in spills of all sizes. A loose 'rule rule-of of-thumb' that is often used in poorly documented spills is that the overall mortality is ten times the actual body count. There is no justification for this notion. The mean estimate is 4 4–5 times the body count, but each spill should be examined independently."
- In addition, it should be noted that the wildlife search effort following the DWH event was unprecedented in its scope and intensity, and that some carcasses were collected on the Atlantic Coast of Florida, an area that was not directly impacted by the spill.
- **References:**

API 2 COMMENTS 20-23

- Burger, A.E., 1993, Estimating the mortality of seabirds following oil spills: Effects of sill volume. Marine Pollution Bulletin (1993). Volume: 26, Issue: 3, Pages: 140-143.

21. The DEIS characterizes the number of birds collected as a "small fraction" of total mortalities. *See* DEIS B-33.

    - The word "small" should be deleted as the ratios cited indicate that, in some cases, more than half of impacted birds are collected.

Corals

Analysis:

22. The DEIS states, "A full discussion of the fate and behavior of oil from the DWH event on chemosynthetic communities can be found in Chapter 4.1.1.8.1. Depending on how long it remained in the water column, oil may have been well-dispersed and thoroughly degraded by biological action before contact with the seafloor." *See* DEIS 4-140.

    - Studies have shown that oil from the DWH event experienced high rates of biodegradation and, in fact, one study found no seafloor impact at distances greater than 3km from the wellhead.
    - **References:**
        - Hazen, T. C., et al., 2010, Deep-Sea Oil Plume Enriches Indigenous Oil-Degrading Bacteria, Science 330:204-208.
        - Boehm, P. D., et al., 2011, Distribution and Fate of PAH and Chemical Dispersants in the Water Column Following the Deepwater Horizon Oil Spill, SETAC North America 32nd Annual Meeting, November 13-17, Boston, Massachusetts, USA.
        - Boehm, P.D., et al., 2011, Aromatic Hydrocarbon Concentrations in Seawater: Deepwater Horizon Oil Spill, International Oil Spill Conference, May 23-26, Portland, Oregon, USA.
        - Operational Science Advisory Team (OSAT), 2010, Summary report for sub-sea and sub-surface oil and dispersant detection: Sampling and monitoring, Unified Area Command, New Orleans, LA, Released on December 17, 2010.

23. The DEIS states, "A catastrophic spill, like the DWH event, could affect non-chemosynthetic community habitat if dispersants are applied on the sea surface or at depth. The dispersed oil would be suspended in the water column and travel with currents." *See* DEIS 4-145. Similarly, the DEIS states, "Oil that is released would normally rise rapidly to the sea surface. However, if the oil release is treated with dispersants at depth, it would disperse at depth and a plume of oil would be carried in whatever direction the water currents flow." *See* DEIS 4-642.

API 2 COMMENTS 23-24

- These statements imply that non-chemosynthetic community habit would only be affected if dispersants are applied following a deepwater spill like the DWH event. However, natural turbulence during any deepwater spill will cause significant dispersion of oil into the water column even in the absence of dispersants, thus potentially affecting non-chemosynthetic community habitat. Coupled with natural turbulence, subsea dispersants could further break up the oil and decrease droplet size. Moreover, this effect would only occur if the dispersed oil plume came into contact with the seafloor. In the DWH event, the plume was suspended above the seafloor. This statement should be clarified accordingly.
- Pre-DWH studies conducted by SINTEF (Johansen 2001) demonstrated that physical forces would disperse oil into small droplets during a subsea release. Moreover, dissolution will also occur during any subsea release.
- **References:**
    - Adams, E. E. and S. A. Socolofsky, 2004 (revised 2005), Review of Deep Oil Spill Modeling Activity Supported by the DeepSpill JIP and Offshore Operators Committee, DeepSpill JIP and Offshore Operators Committee.
    - Johansen, Ø. et al., 2000, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Cruise Report, SINTEF STF66 F00093.
    - Johansen, Ø. et al., 2001, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Technical Report, SINTEF STF66 F01082.
    - Johansen, Ø. et al., 2001, ROV sonar and visual pictures from the field trial "Deep Spill", June 2000, SINTEF.

24. The DEIS states, "However, subsea oil plumes resulting from a seafloor blowout could affect sensitive deepwater communities. This is especially true if dispersants are applied at depth. A recent report documents damage to a deepwater coral community in an area that oil plume models predicted as the direction of travel for subsea oil plumes from the DWH event. Results are still pending but it appears that a coral community about 15 m x 40 m (50 ft x 130 ft) in size was severely damaged, possibly the result of oil impacts (USDOI, BOEMRE, 2010j)." *See* DEIS 4-149; *see also* DEIS 4-100; 4-549; 4-557; 4-654 to 4-655; 4-687.

    - This statement should be clarified to state that subsurface oil releases will produce dispersed oil in the subsea as a result of natural turbulence, irrespective of whether any dispersants are used on the oil.
    - The description of the report should be clarified as follows: "In November 2010, a survey of deepwater corals at a site 1,400 meters deep (roughly 4,600 feet) located approximately seven miles southwest from the Macondo wellhead revealed a 15 to 40 m (49 to 131-ft) area of dead and dying corals. Results are still pending, however. The location of this coral was in an area that oil plume models predicted as the direction of travel for subsea oil plumes from the DWH event."

API 2 COMMENTS 25-28

25. The DEIS states, "Oil plumes reaching chemosynthetic communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats." *See* DEIS 4-639.

- This statement is not currently supported by evidence or studies. Lab analysis has not yet confirmed that coral found damaged after the DWH event was due to oil impacts. Further, the term plume implies a heavy coating of oil, which did not occur. If deep sea oil reached chemosynthetic communities, it would be a dispersed cloud of oil droplets, less likely to impact a localized habitat population.

26. The DEIS states, "A catastrophic spill, like the DWH event, could affect chemosynthetic community habitat if oil is ejected into deep water under high pressure, resulting in vigorous turbulence and the formation of microdroplets or if dispersants are applied on the sea surface or at depth (Appendix B)." *See* DEIS 4-638.

- This statement is incorrect in that "dispersants . . . applied on the sea surface" would not be expected to introduce microdroplets to the water column below a depth of approximately 6 to 10 meters and, therefore, it is not clear how chemosynthetic communities on the ocean floor would be affected. Thus, the phrase "on the sea surface or" should be deleted.

27. The DEIS states, "Habitats directly in the path of the oil plume when the oil contacts the seafloor would be affected, but most oil would reach the seafloor in a widely scattered and decayed state. In addition, sublethal effects are possible for communities that receive a lower level of impact. These effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, loss of tissue mass, and similar effects." *See* DEIS 4-639.

- A reference that discusses potential sublethal effects of low oil concentrations on chemosynthetic communities should be provided or the reference to possible sublethal effects should be removed.
- Moreover, it should be noted this effect would only occur if the dispersed oil plume came into contact with the seafloor. In DWH, the plume was suspended above the seafloor.

28. The DEIS notes, "Sensitive deepwater communities appear to be widely scattered and not as rare as previously expected." *See* DEIS 4-655.

- Prior to the DWH incident, there had been many surveys of deepwater communities and seeps, which are often associated with chemosynthetic communities.
- **References:**
  - Boland et al. 2010. Mississippi Canyon 252 Incident NRDA Tier 1 for Deepwater Communities, *available at* http://www.nature.nps.gov/environmentalquality/OilSpillWorkplans/docs/2010_07_02_Deepwater_Communities_Signed.pdf.

API 2 COMMENTS 28-31

  - Kornacki, SETAC 2011, Geochemistry and Origin of Naturally-Occurring Hydrocarbons in Sediments from Northeast Mississippi Canyon Deepwater Gulf of Mexico.

29. The DEIS states, "Recent BOEM analyses of seafloor remote-sensing data indicate over 15,000 locations in the deep GOM that represent potential hard-bottom habitats." *See* DEIS 4-655.

- A citation for this statement should be provided.

30. The DEIS refers to "available data indicating the impacts to Pinnacle Trend features as a result of the DWH event," but goes on to acknowledge that available data suggests that such impacts are unlikely. *See* DEIS 4-529, 4-535.

- The statement should be revised to read "available data indicating *any* impacts to Pinnacle Trend features as a result of the DWH event."

31. The DEIS states, "Harbor Branch Oceanographic Institute and the NOAA Cooperative Institute for Ocean Exploration, Research, and Technology conducted the Florida Shelf-Edge Expedition (FLoSEE) following the DWH event from July 9 to August 9, 2010. The expedition focused on the following: (1) the assessment and documentation of deepwater coral reefs, shelf-edge mesophotic reefs, and hard-bottom essential fish habitat; (2) stress responses of corals and other marine invertebrates exposed to oil and chemical dispersants; (3) assessment of zooplankton and linkages between pelagic and benthic ecosystems; (4) chemical analysis of sessile benthic taxa and biomedical resources; and (5) education and outreach(Reed and Rogers, 2011). Survey sites along the east, south, and west Florida shelf and slope were partially selected based on the path of the oil plume. Particular sites of interest included Miami Terrace, Pourtales Terrace, Tortugas Ecological Reserve, Florida Keys National Marine Sanctuary, Pulley Ridge, Naples sinkhole, Lophelia Reefs, Sticky Grounds, Florida Middle Grounds, and Madison-Swanson Marine Protection Area. Videotape and photographs were taken from a submersible and specimens were collected and catalogued. Once more data are released, we will have a better understanding of the measured impacts and possible long-term effects of this event." *See* DEIS 4-564.

- This discussion should mention that no published studies have cited coral damage in these areas that is associated with the spill.
- This discussion should note that there was no documented surface or subsea exposure at these "particular sites of interest."

Dispersants

API 2 COMMENTS 32-33

Analysis:

32. The DEIS states, "Impacts from the DWH event to surface water in the WPA are therefore highly unlikely. The use of dispersants at the wellhead resulted in the creation of a subsea dispersed oil plume and/or diminished dissolved oxygen signature of impact of the oil." *See* DEIS 4-6.

- While dispersants can cause the creation of subsea dispersed oil droplets, natural turbulence during any deepwater spill will cause significant dispersion of the oil independent of the use of any dispersants. The use of dispersants in naturally turbulent water, however, can further disperse the oil and decrease the size of oil droplets (SINTEF DEEPSPILL Study).
- As opposed to characterizing the resulting oil concentration from the use of dispersants as a "subsea dispersed oil plume," it would be more accurate to characterize the oil as "dispersed oil" or "clouds of dispersed oil" given that the oil concentrations were in the low parts per million range or lower and the oil did not present as a continuous subsea slick (Atlas and Hazen (2011)).
- **References:**
    - Adams, E. E. and S. A. Socolofsky, 2004 (revised 2005), Review of Deep Oil Spill Modeling Activity Supported by the DeepSpill JIP and Offshore Operators Committee, DeepSpill JIP and Offshore Operators Committee.
    - Johansen, Ø. et al., 2000, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Cruise Report, SINTEF STF66 F00093.
    - Johansen, Ø. et al., 2001, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Technical Report, SINTEF STF66 F01082.
    - Johansen, Ø. et al., 2001, ROV sonar and visual pictures from the field trial "Deep Spill", June 2000, SINTEF.
    - Atlas, R. M. and T. C. Hazen, 2011, Oil Biodegradation and Bioremediation: A Tale of the Two Worst Spills in U.S. History, Environ. Sci. Technol. 45(16):6709-6715.

33. The DEIS states, "In the case of the DWH event, the application of the dispersant (Corexit 9500) at the seafloor and the surface was alleged to have had the potential to produce larger areas of subsurface anoxic water because of the degradation of oil by bacteria." *See* DEIS 4-313.

- This statement is not supported by the evidence. As noted elsewhere in the DEIS (*e.g.*, Hypoxia from Oil Biodegradation section, page 4-158) and in the JAG DO report, anoxic conditions were not produced after the DWH event and oxygen depletion levels have stabilized. There is no evidence to suggest that anoxic conditions will develop in the future as the result of the DWH event.

API 2 COMMENTS 33-35

- **References:**
    - Joint Analysis Group (JAG), 2010b, Review of Preliminary Data to Examine Oxygen Levels In the Vicinity of MC252#1 May 8 to August 9, 2010. August 16.

34. The DEIS states, "In the case of the DWH event's resulting spill (consisting of a combination of oil and gas), it has been suggested that the addition of dispersants at the seafloor has resulted in large subsurface clouds of elevated methane concentrations." *See* DEIS 4-314.

- There is no documentation to suggest that dispersant application results in increased methane dissolution into the water column. As reported by Kessler et al. 2011, Ryerson et al. 2011, etc., methane is expected to dissolve in the water column. Natural turbulence (leading to dispersion) and gas dissolution would be the main forces causing methane to remain in the subsurface.
- **References:**
    - Kessler, J. D., et al., 2011, A Persistent Oxygen Anomaly Reveals the Fate of Spilled Methane in the Deep Gulf of Mexico, Science 331(6015):312–315.
    - Ryerson, T. B., et al., 2011, Atmospheric emissions from the Deepwater Horizon spill constrain air water partitioning, hydrocarbon fate, and leak rate, Geophysical Research Letters 38:L07803.

35. The DEIS states, "Much of the oil was treated with dispersant at the sea surface and at the source in 1,500 m (5,000 ft) of water depth. It is reported that chemically dispersed surface oil from the DWH event remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded (Lubchenco, et al., 2010). Data from other studies on dispersant usage on surface plumes indicate that a majority of the dispersed oil remained in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Any dispersed oil that reached the seafloor from the water's surface during this event would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to adhere to particles in the water column, delaying flocculation and sinking to the seafloor (McAuliffe et al., 1981a). Oil exposed to dispersant chemicals became more dispersed and less concentrated the longer it remained floating or suspended in the water column. These oil droplets remained neutrally buoyant in the water column, creating a subsurface plume of oil (Adcroft et al., 2010). Concentrations of dispersed and dissolved oil in the subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010)." *See* DEIS 4-123.

- Because McAuliffe is not a DWH-specific study, the references to McAuliffe should be supplemented with references to, and discussion of, DWH-specific results presented by BenKinney at the 2011 IOSC Meeting.

API 2 COMMENTS 35-38

- The oil droplets referenced in Adcroft et al., 2010 were small droplets below 100 micron, not specifically chemically dispersed oil. This discussion appears to focus on surface oil treated with dispersants, but there is no evidence that this oil contributed to the subsurface dispersed oil. This sentence should be revised to make that distinction clear.
- The final sentence should clarify that ppm level results were observed only very near the well, with concentrations falling by an order of magnitude within 10-50 km.
- **References:**
  - M. BenKinney et al., 2011, Monitoring Effects of Aerial Dispersant Application during the MC252 Deepwater Horizon Incident, IOSC, Portland, OR.

36. The DEIS states, "The use of dispersant causes oil to mix with the water and travel laterally with water currents, ultimately leading to precipitation on the seafloor in some form (Whittle et al., 1982; ITOPF, 2002)." *See* DEIS 4-638.

- This statement is misleading, as most dispersed oil is expected to become neutrally buoyant and remain in the water column until it is dissolved, biodegraded, or, sometimes, precipitated.

37. The DEIS repeatedly refers to biodegraded oil components as oil. *See, e.g.*, DEIS 4-638; 4-655.

- If found in marine detritus, biodegraded oil components are in a sufficiently different form that the term "oil" no longer applies.

38. The DEIS states, "Oil that is released would normally rise rapidly to the sea surface. However, if the oil release is treated with dispersants at depth, it would disperse at depth and a plume of oil would be carried in whatever direction the water currents flow. This directional flow could only affect seafloor habitats that are downstream from the source. Though the oil plume could be carried into direct contact with the seafloor at some distance from the source, a more likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; ITOPF, 2002)." *See* DEIS 4-655; *see also* DEIS 4-838 ("The addition of Corexit 9500 at the seafloor spill site and the surface resulted in the dispersion of oil in the water column.").

- The statement that "[o]il that is released would normally rise rapidly to the sea surface" is not accurate for a deepwater release, even in the absence of dispersants. Natural turbulence during any deep spill will cause significant dispersion of oil into the water column, although subsea dispersants can further break up the oil and decrease droplet size. That is, the dispersion of subsurface oil resulted from a combination of natural turbulence and chemical dispersants, where used (Johansen, et al., 2011, SINTEF DEEPPILL Study).

API 2 COMMENTS 38-40

- Oil typically floats in water, and would only precipitate to the seafloor if mixed with a heavier substance, such as drilling mud, which would typically occur close to the drilling source. There is no evidence that oil would reach the seafloor "much like rainfall" at significant distance from the source.
- If found in marine detritus, however, biodegraded oil components are in a sufficiently different form that the term "oil" no longer applies.
- **References:**
  - Adams, E. E. and S. A. Socolofsky, 2004 (revised 2005), Review of Deep Oil Spill Modeling Activity Supported by the DeepSpill JIP and Offshore Operators Committee, DeepSpill JIP and Offshore Operators Committee.
  - Johansen, Ø. et al., 2000, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Cruise Report, SINTEF STF66 F00093.
  - Johansen, Ø. et al., 2001, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Technical Report, SINTEF STF66 F01082.
  - Johansen, Ø. et al., 2001, ROV sonar and visual pictures from the field trial "Deep Spill," June 2000, SINTEF.

39. The DEIS states, "The negative effect [of dispersant use] is that the oil, once dispersed, is more available to microorganisms and temporarily increases the toxicity (Bartha and Atlas, 1983)." *See* DEIS 4-453; *see also* DEIS 4-465.

- This statement should be rephrased to clarify that dispersed oil does not have a higher toxic content than undispersed oil, but rather increases the distribution and surface area of the oil and therefore increases exposure to oil in the water column.
- This statement also should note that sampling conducted during the DWH response confirms that dispersed oil concentrations drop quickly, so that any exposures of dispersed oil would be short-lived, decreasing the risk of excess toxicity.

40. The DEIS states, "A recent study assessed the impacts of Corexit EC9500A, which was widely deployed during the DWH event, on microbial communities from a beach impacted by the spill (Hamdan and Fulmer, 2011). The findings suggest that hydrocarbon-degrading bacteria from the oiled beach were inhibited by chemical dispersants and that the use of dispersants has the potential to diminish the capacity of the environment to bioremediate spills." *See* DEIS 4-454.

- This discussion overstates the conclusions of Hamdan and Fulmer and should provide more detail regarding the study. This study was performed in lab using water spiked with dispersant, not in the field. As a result, this discussion should clarify that the findings of the study do not necessarily reflect conditions during the DWH spill. Hamdan and Fulmer collected microbial communities in oil from the beach, then added water with dispersant concentrations of 1:10, 1:25, and

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1:50, meant to represent the maximum levels potentially encountered in the environment immediately after dispersant application to surface slicks and at the wellhead. These concentrations were not intended to represent dispersant concentrations in the water column or on beaches, which the authors note would be significantly lower. In fact, it is likely that the microbial communities collected from the beach had been exposed to the low levels of dispersants present during the DWH event, without evident toxicity. The study was intended to determine the potential effect of dispersants on microbial communities, not to represent actual conditions on the impacted beach.

- Significant dispersant impacts on microbial communities in Hamdan and Fulmer were most likely at concentrations in excess of 1 mg/L, far above environmental levels observed during the DWH spill (*see* data from Kujawinski and BenKinney and data discussed later in the paragraph, showing dispersant component concentrations 100s of times below this concentration). This discussion should be revised to indicate that the study suggests microbial impacts could occur at very high dispersant concentrations if microbial communities were exposed to these concentrations for extended periods of time.
- **References:**
  - Kujawinski, E.B., M.C. Kido Soule, D.L. Valentine, A.K. Boysen, K. Longnecker, and M.C. Redmond. 2011. Fate of dispersants associated with the Deepwater Horizon oil spill. Environmental Science & Technology. 45: 1298-1306.
  - M. BenKinney et al., 2011, Monitoring Effects of Aerial Dispersant Application during the MC252 Deepwater Horizon Incident, IOSC, Portland, OR.

41. The DEIS states, "Since the amount of dispersants used for the spill resulting from the DWH event is unprecedented and since this is the first time dispersants have been applied in such quantities on the surface in deep waters, and at the depth of the well itself, continual monitoring and evaluation of their use is imperative to be sure, for example, that hypoxic conditions are not reached in subsurface waters (White House Press Briefing, 2010)." *See* DEIS 4-465.

- This discussion should mention the OSAT and JAG DO dissolved oxygen data showing the absence of hypoxic conditions or the reference to "hypoxic conditions" should be removed altogether.

42. The DEIS states, "A large volume of chemical dispersants was applied during the DWH oil spill, equaling 1.84 million gallons of dispersant used to breakup and dilute the oil subsea at the wellhead and on the surface (Oil Spill Commission, 2011d). The most heavily used dispersant formulation was the Corexit® series, which contains a complex mixture of monomeric and polymeric surfactants including the anionic surfactant dioctylsulfosuccinate, polyoxyethylene sorbitan mono- and trioleates, and sorbitan monooleates (Getzinger and Ferguson, 2011). Sediment and water samples collected in the offshore and deepwater zones were analyzed for a number of dispersant-related chemicals, but predominantly DPnB (OSAT, 2010). Between mid-

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June and mid-October, a total of 4,916 water and sediment samples were collected in the offshore and deepwater zones." *See* DEIS 4-471.

- The statement "the most heavily used dispersant formulation was the Corexit® series" should read "the only dispersant formulation used was the Corexit® series." It should also clarify that the use of Corexit 9527 was stopped in May 2010.
- The statement "sediment and water samples collected in the offshore and deepwater zones were analyzed for a number of dispersant-related chemicals, but predominantly DPnB (OSAT, 2010)" should clarify that DPnB was not the most frequently analyzed dispersant chemical, though it was the most commonly detected.
- The statement "Between mid-June and mid-October, a total of 4,916 water and sediment samples were collected," should be corrected to note that samples were collected starting May 9, 2010. Also, as this data seems to come from OSAT 2010, additional citations to that report are needed.

43. The DEIS states, "However, for offshore spills the dispersal of about 65 percent of the volume of a spill is attributed to the use of dispersants." *See* DEIS 4-493.

- This statement needs a citation and, as currently worded, is not consistent with Table 3-23. The figure also does not take into account natural dispersion, evaporation, dissolution and other active response techniques.

Economic Impacts

44. The DEIS states, "An event like the DWH event could have adverse and disproportionate effects for low-income and minority communities in the analysis area. Many of the long-term impacts of the DWH event to low income and minority communities are unknown." *See* DEIS 2-32; *see also* DEIS 2-65.

- If there is evidence to support the implication that the spill had a disproportionate impact on any specific minority group, this should be cited. If not, this statement should be rephrased to clarify that the existence of any long-term impacts of the DWH event to low income and minority communities is speculative.

45. The DEIS states, "Gentner Consulting Group (2010) attempts to quantify the potential losses to State economies due to recreational fishing closures in light of the DWH event. This study uses the expenditure estimates and input-output modeling framework of Gentner and Steinbeck (2008) to derive a daily measure of the potential losses in the economy due to fishing closures in the Gulf of Mexico." *See* DEIS 4-340.

- The Getner (2010) report appears not to be supported by recent evidence regarding the speed of economic recovery in the Gulf.
- It should be noted that the overwhelming majority of the Gulf of Mexico consists of federal waters. By November 2010, 99.6% of federal waters were open, 98.5%

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of Louisiana waters were open, all Florida waters were open, and all waters in Alabama and Mississippi were open with the possible exception of some oyster closures.

- Recreational fishing showed signs of recovery in 2011. Preliminary catch data in the Northern Gulf indicates the seatrout and the red drum catch in the first half of 2011 were about 10% and 20% higher respectively than the comparable five-year average prior to the spill according to the National Marine Fisheries Service.[1]
- In addition, as discussed below, multiple lines of evidence demonstrate that, to the extent that tourism revenues in the Gulf were impacted by the spill, recovery had occurred by the end of 2010, and that positive economic performance continued into 2011, with 2011 economic metrics exceeding pre-spill performance.
- **References:**
  - http://www.noaanews.noaa.gov/stories2010/20101115_reopening.html (showing that as of Nov. 15, 2010, 99.6% of federal waters were open).
  - http://www.wlf.louisiana.gov/news/33303 (showing that as of November 5, 2010, 98.5% of Louisiana waters were open for fishing).
  - http://myfwc.com/OilSpill (showing that the areas of closures in Florida (off Escambia county) were reopened on September 16, 2010).
  - http://myfwc.com/news/news-releases/2010/august/16/news_10_x_oilspill39/ (showing that the areas of closures in Florida (off Escambia county) were reopened on September 16, 2010).
  - http://myfwc.com/news/news-releases/2010/july/31/news_10_x_oilspill36/ (showing that the areas of closures in Florida (off Escambia county) were reopened on September 16, 2010).
  - http://www.outdooralabama.com/news/release.cfm?ID=838 (showing that all waters that were closed for fish, shrimping, and crabs were re-opened in September, 2010).
  - http://www.outdooralabama.com/news/release.cfm?ID=833 (showing that all waters that were closed for fish, shrimping, and crabs were re-opened in September, 2010).
  - http://www.outdooralabama.com/fishing/saltwater/dh.cfm(showing that all waters that were closed for fish, shrimping, and crabs were re-opened in September, 2010).
  - http://www.dmr.ms.gov/news-a-events/news-archive/174-2010-news-releases (showing that by November 2010, all state waters were open for all species except oysters).

[1] *"Preliminary recreational catch data in the Northern Gulf, National Marine Fisheries Service 1H of 2011.*

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  - National Marine Fisheries Service, Preliminary recreational catch data in the Northern Gulf, *available at* http://www.st.nmfs.noaa.gov/st1/recreational/queries/index.html.

46. The DEIS states, "The Gulf Coast recreation/tourism economy has generally performed well in past years. However, events such as hurricanes, the recent global economic downturn, and the DWH event and resulting oil spill have strained various components of the recreation and tourism industries; they have also affected the baseline conditions for these industries in some regions." *See* DEIS 4-343.

- The reference to "baseline conditions" is unclear. If the DEIS language is intended to convey that previous hurricanes and the global economic downturn affected the baseline against which potential spill impacts should be measured, this should be clarified.
- Multiple lines of evidence demonstrate that, to the extent that portions of the Gulf recreation/tourism economy were impacted by the spill, recovery had occurred by the end of 2010, and that positive economic performance continued into 2011, with 2011 economic metrics exceeding pre-spill performance. For example:
  - During the first quarter of 2011, hotels in coastal areas of the Gulf states performed well above first quarter (pre-spill) 2010 levels.
  - Tourist businesses in the Gulf region reported strong, and in some cases, record, springs, Memorial Day weekends, and Fourth of July holidays.
  - According to the New Orleans Convention and Visitors Bureau, tourist dollars spent in the city in 2010 were at a record high and exceeded 2009 by more than $1.1 billion dollars.
- **References:**
  - New Orleans Times Picayune, "New Orleans tourism officials expect one of the strongest springs ever," Apr. 3, 2011.
  - Pensacola News Journal, "Tourism tide turns for Pensacola Beach," April 1, 2011.
  - PR Newswire, "New Orleans Achieves Major Tourism Milestone: 8.3 Million Visitors in 2010 Spent 5.3 Billion Dollars, The Most Visitor Spending in City History," Apr. 14, 2011.
  - USA Today, "Alabama: Gulf Shores," p. 6A, August 4, 2011.
  - Decatur Daily, "Record Tourism Revenues on Gulf," Sept. 2, 2011.
  - Foxnews.com, "Gulf Coast Sees Record Tourism Rebound After Deepwater Horizon Oil Spill," Dec. 28, 2011.

47. The DEIS states, "CoreLogic (2010) and Bloomberg (2010) provide estimates of the extent to which the DWH event will negatively impact property values in the Gulf of Mexico. Bloomberg (2010) forecasted a loss of $4.3 billion in property values, while CoreLogic (2010) forecasted a loss of $3 billion in the 15 most affected coastal counties over 5 years." *See* DEIS 4-348; *see also* DEIS 4-885 to 4-886; 4-884.

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- The CoreLogic study is outdated. It was published in August of 2010.
- The statement that the CoreLogic study "forecasted a loss of $3 billion" mischaracterizes the study. The study forecasted a loss "as much as $3 billion," or "potentially as high as $3 billion." Accordingly, this statement should be revised.
- The CoreLogic study relied on various assumptions now known to be false. Of note, the study assumed that oil would affect the coast for 5 years. For example, the report states, "Finally, we assume that the recreational value of beach access is restricted by the oil spill for five years to estimate the value of beach access at risk of being lost."
- The provided Bloomberg citation is no longer accessible. A new cite, therefore, needs to be provided.

48. The DEIS states, "Oxford Economics (2010) attempts to quantify these effects by analyzing the impacts of recent catastrophic events on recreational economies. For example, they analyzed the *Ixtoc* oil spill of 1979, the scale and nature of which is reasonably similar to the DWH event. In this example, it took approximately 3 years for beaches to be cleaned and for recreational activity to return to similar levels as before the spill. They also looked at the *Prestige* oil spill of 2002 off the coast of Spain. Given the nature and size of that spill, recreational activity was able to return to pre-spill levels in approximately 1 year. Alaska's tourism economy took approximately 2 years to recover from the *Exxon Valdez* spill. Oxford Economics (2010) predicts that the long-term economic damage from the DWH event's resulting spill will be between $7.6 and $22.7 billion. Given Florida's dependence on fishing and beach activities (as well as the overall size of its economy), this study suggests that the State might bear the majority of the economic damage from the spill even though it experienced fewer physical impacts than did other states." *See* DEIS 4-350; *see also* DEIS 4-886; B-47.

- The methodology used in the Oxford Economics (2010) report should be critically reviewed, particularly the assumptions used in developing the report. The report relies on case studies that are inappropriate to compare to the DWH event.
- More recent data disputes the results from the Oxford Economics (2010) report.
  - For instance, the Report cites as "uncertainties" whether flow from Macondo well will be permanently halted and where the oil goes. Uncertainty about these issues has been substantially resolved.
  - Similarly, the NOAA oil flow scenarios relied upon in the report are now known to be incorrect, as oil never entered the Loop Current or went beyond the panhandle of Florida.
  - In addition, the report's prediction that it would take 15 to 36 months for Gulf tourism to recover from the spill is inconsistent with recent reports and data reflecting strong and even record levels of tourism in the Gulf in 2011.
- **References:**

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  - New Orleans Times-Picayune, "Armstrong Airport in high gear. More travelers than usual attracted," March 5, 2011.
  - WBRC, "Beach tourists return home satisfied," March 18, 2011.
  - Miami Herald, "More for the traveler: museums, thrill rides," March 27, 2011.
  - Pensacola News Journal, "Tourism tide turns for Pensacola Beach," April 1, 2011.
  - Local15tv.com, "Beach Businesses Seeing Spring Break Boost," April 1, 2011.
  - New Orleans Times Picayune, "New Orleans tourism officials expect one of the strongest springs ever," Apr. 3, 2011.
  - PR Newswire, "New Orleans Achieves Major Tourism Milestone; 8.3 Million Visitors in 2010 Spent 5.3 Billion Dollars, The Most Visitor Spending in City History," Apr. 14, 2011.
  - USA Today, "Alabama: Gulf Shores," p. 6A, August 4, 2011.
  - Decatur Daily, "Record Tourism Revenues on Gulf," Sept. 2, 2011.
  - Foxnews.com, "Gulf Coast Sees Record Tourism Rebound After Deepwater Horizon Oil Spill," Dec. 28, 2011.

49. The DEIS states, "The DWH event has had a number of effects on the commercial fishing industry. The most direct manner in which the spill affects the industry is through the potential for decreased harvests of a number of species over the next few years." *See* DEIS 4-859.

- The referenced potential effects on fishing are highly speculative. There are data that show the shrimping and other fishing industries rebounded after the spill and did quite well through 2011.
- It should be noted that the overwhelming majority of water in the Gulf of Mexico is federal waters. By November 2010, 99.6% of federal waters were open, 98.5% of Louisiana waters were open, all Florida waters were open, and all waters in Alabama and Mississippi were open with the possible exception of some oyster closures.
- **References:**

  - http://www.noaanews.noaa.gov/stories2010/20101115_reopening.html (showing that as of Nov. 15, 2010, 99.6% of federal waters were open).
  - http://www.wlf.louisiana.gov/news/33303 (showing that as of November 5, 2010, 98.5% of Louisiana waters were open for fishing).
  - http://myfwc.com/OilSpill (showing that the areas of closures in Florida (off Escambia county) were reopened on September 16, 2010).

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  - http://myfwc.com/news/news-releases/2010/august/16/news_10_x_oilspill39/ (showing that the areas of closures in Florida (off Escambia county) were reopened on September 16, 2010).
  - http://myfwc.com/news/news-releases/2010/july/31/news_10_x_oilspill36/ (showing that the areas of closures in Florida (off Escambia county) were reopened on September 16, 2010).
  - http://www.outdooralabama.com/news/release.cfm?ID=838 (showing that all waters that were closed for fish, shrimping and crabs were re-opened in September, 2010).
  - http://www.outdooralabama.com/news/release.cfm?ID=833 (showing that all waters that were closed for fish, shrimping and crabs were re-opened in September, 2010).
  - http://www.outdooralabama.com/fishing/saltwater/dh.cfm(showing that all waters that were closed for fish, shrimping and crabs were re-opened in September, 2010).
  - http://www.dmr.ms.gov/news-a-events/news-archive/174-2010-news-releases (showing that by November 2010, all state waters were open for all species except oysters).

- Indeed, publicly available fish landings data show that shrimp and menhaden catches were strong once fishing grounds were reopened. For example, according to NOAA data, December 2010 was the best December in the last five years with regard to total Gulf shrimp landings. While there has been variability in certain months in certain states, total shrimp landings in 2011 were well within the range for 2007 through 2009, and were in fact approximately equal to the average landings for this period.
- **References:**
  - NOAA, Status Purse-Seine Landings of Gulf and Atlantic Menhaden for the 2011 Fishing Season, (July 5, 2011), *available at* http://www.st.nmfs.noaa.gov/st1/market_news/doc77.txt.
  - NOAA Fisheries Service, May 2011 Shrimp Statistics, *available at* http://www.st.nmfs.noaa.gov/st1/market_news/doc45.txt.

50. The DEIS states, "While, at this time, there exists substantial uncertainty regarding the range and magnitude of these effects, IEM (2010) attempts to create estimates of the economic effects of lower harvests on the economy of the Louisiana." *See* DEIS 4-859.

- A cite to the IEM report needs to be provided.

51. The DEIS states, "Payments from BP also helped mitigate the financial damage to some individuals and businesses to some extent; as of June 28, 2011, $134 million in damage claims had been paid to individuals and $538 million had been paid to firms in

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the fishing industry in the GOM (Gulf Coast Claims Facility, 2011a)." *See* DEIS 4-859.

- These figures for businesses and the fishing industry should be updated. As of January 30, 2012, BP has paid over $603 million to businesses in the fishing industry.
- **References:**
  - Gulf Coast Claims Facility, Overall Program Statistics (Jan. 30, 2012), *available at* http://www.gulfcoastclaimsfacility.com/GCCF_Overall_Status_Report.pdf.

52. The DEIS states, "Catastrophic spills have a huge regional economic impact, as seen recently in the DWH event. It is estimated that the total economic consequences of the DWH event will lead to a net loss of just under $20 billion for the U.S. economy in 2010, which would lower U.S. economic growth in 2010 by roughly 0.1 percent and would reduce growth to a greater extent in the four states most affected." *See* DEIS B-48.

- These statements should be supported by a citation.
- The use of the word "huge" is unclear without further elaboration and without a citation.
- These statements imply that the DWH event is solely responsible for lowering the country's economic growth, which does not appear to be supported by the evidence. Other causes, including the global economic downturn, clearly played a role in lowering the country's economic growth.

Environmental Justice

53. The DEIS states, "In prior post-spill cleanup efforts, the duration of cleaning work was a risk factor for acute toxic symptoms, and seamen had the highest occurrence of toxic symptoms compared with volunteers or paid workers (Sathiakumar, 2010). Therefore, participants in the DWH "Vessels of Opportunity" program, which recruited local boat owners (including Cajun, Houma Indian, and Vietnamese fishermen) to assist in cleanup efforts, would likely be one of the most exposed groups. African Americans are thought to have made up a high percentage of the cleanup workforce." DEIS 4-966*; see also* DEIS 4-422; 4-428; 4-960; B-49.

- This discussion should note several important differences between the cleanup efforts examined by Sathiakumar and the DWH response that should caution against applying the results of that study to DWH:
  - Potential exposures during DWH were materially different from those in previous spills due, in part, to the distance from the source to shore and the weathering of the DWH oil before it surfaced (which, for instance, removed

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benzene and significantly reduced concentrations of toluene, ethylbenzene, and xylenes);

- Sathiakumar's review focused on spills from tanker ships, not subsurface releases, and therefore the oil that surfaced in those spills would have different compositions than the significantly-weathered DWH oil that reached the surface;
- Sathiakumar's observation that "seamen" have the highest occurrence of toxic systems does not, by implication, mean that VOO operators had the highest potential exposures in the DWH response. In fact, VOO workers in the DWH response were not allowed into the source control area near the wellhead and, as a result, their potential exposures would be expected to be lower than professional source control operators. Also, there is no indication in Sathiakumar's study that the tasks, PPE, and training of the "seamen" were comparable to those of DWH VOO workers.

- This discussion should also be revised to conform with the later DEIS statement that "Past accidental oil-spill events do not provide guidance for the assessment of the long-term impact of the DWH event on public health." *See* DEIS 4-441.
- The report does not discuss that several health assessments of worker exposures have already been completed. NIOSH Health Hazard Evaluation reports are available for a variety of response worker tasks. OSHA also issued a fact sheet statement based on its sampling efforts.
  - Symptoms such as headache, upper respiratory irritation or congestion, nausea, elevated self-monitored blood pressure, fatigue, and chest pain or pressure were reported in some workers. The symptoms were initially attributed to dispersants, but NIOSH investigators later concluded that dispersant use was unlikely to be the cause; instead, unpleasant odors, heat, and fatigue played a significant role (Interim Report #1). NIOSH monitored response workers in different roles (e.g. skimming, decontamination) for VOCs, dispersant compounds, CO, and other compounds, and found that personal and area concentrations were below occupational exposure limits. The NIOSH reports discuss their evaluation of acute health effects (NIOSH 2010).
  - "Exposure to any of these hazards depends on what you are actually doing and where you are working. For example, heat stress is a real concern for all outdoor activities because the weather is hot and humid. If you are pulling in oil-covered booms, then contact with weathered oil, drowning, and back injuries are also concerns. Most jobs will only involve contact with weathered oil, which no longer has high levels of hazardous chemicals that can get into the air. To make sure, OSHA is monitoring the air that workers breathe for the hazardous chemicals common in oil and dispersants, as well as other chemicals like carbon monoxide. To date, no air sampling by OSHA has detected any hazardous chemical at levels of concern." (OSHA 2010).

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  - In response to concerns about airborne exposures to dispersant components (particularly 2-butoxyethanol, a component of Corexit 9527), OSHA noted, "Approximately 80% of the 1048 samples BP analyzed showed 'no detectable level' of 2-butoxyethanol. Of the remaining 20% (n=213) of the samples with any detectable 2-butoxyethanol, the highest level measured was 0.8 ppm, and 90% of these were 0.2 ppm or less. Every measurement was well below the NIOSH recommended limit of 5.0 ppm . . . . Most exposure measurements found no exposure to the chemical, and all exposure levels detected were well below any occupational exposure limit."

- **References:**

  - National Institute of Occupational Safety and Health (NIOSH), Interim Reports 1-9: Health Hazard Evaluation of Deepwater Horizon Response Workers, (2010), available at http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html.
  - Occupational Safety & Health Administration (OSHA), OSHA Fact Sheet: General Health and Safety Information for the Gulf Oil Spill, (Aug. 19, 2010), http://www.osha.gov/oilspills/deepwater-oil-spill-factsheet-ppe.pdf.
  - OSHA, OSHA Statement on 2-Butoxyethanol & Worker Exposure, (July 2010), available at http://www.osha.gov/oilspills/oilspill-statement.html.

54. Likewise, the DEIS states, "Long-term health surveillance studies of possible long-term health effects from exposure to either the DWH event's oil or dispersants, such as the possible bioaccumulation of toxins in tissues and organs, are lacking, and the potential for the long-term human health effects are largely unknown. . . . In Gulf coastal areas, low-income and minority groups are heavy subsistence users of local seafood. The concern is that heavy subsistence users face higher than expected, and potentially harmful, exposure rates to PAH's from the DWH event." DEIS 4-966; *see also* DEIS 4-961.

- This statement fails to recognize the following factors that caution against a finding of long-term and cumulative health impacts:
  - Worker and shoreline monitoring data indicates that the concentrations of oil and dispersants to which low-income and minority communities were exposed are unlikely to result in adverse health effects. Data from several sources, including OSHA, NIOSH, BP, EPA and the CDC (among others) demonstrated that exposures to DWH oil and dispersants were low and isolated and that there was no evidence of significant on-shore exposure to communities of environmental justice concern. In light of this, it is not clear that DWH-related exposures are significant when compared to background exposures from other sources for coastal residents.
  - Seafood closures reduced potential for oil/dispersant exposures through food. NOAA and state agencies implemented fishery closures in waters impacted or potentially impacted by oil, and did not reopen the fisheries until testing indicated that waters were safe for fishing.

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- Extensive seafood safety testing shows virtually all non-detectable levels of PAHs and dispersant compounds.

- **References:**

  - Dickey, 2011, "FDA Risk Assessment of Seafood Contamination after the BP Oil Spill," Environmental Health Perspectives, http://dx.doi.org/10.1289/ehp.1104539R.
  - OSHA, 2011, OSHA's Efforts to Protect Workers. http://www.osha.gov/oilspills/index.html.
  - NIOSH, 2011, Deepwater Horizon Response: NIOSH Health Hazard Evaluation. http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html.
  - Avens, et al., 2011, Analysis and Modeling of Airborne BTEX Concentrations from the Deepwater Horizon Oil Spill, Environmental Science & Technology, 45:7372-7379.
  - Middlebrook, et al., 2011, Air quality implications of the *Deepwater Horizon* oil spill, PNAS, 10.1073/pnas.1110052108.
  - Brown, A. et al. 2011. Monitoring Polycyclic Aromatic Hydrocarbons (PAHs) in Seafood in Mississippi in Response to the Gulf Oil Spill. Gulf Oil Spill SETAC Focused Topic Meeting. Pensacola, Florida. April 26-28. http://gulfoilspill.setac.org/sites/default/files/abstract-book-1.pdf.
  - US Food and Drug Administration. 2011. Deepwater Horizon Oil Spill: Questions and Answers. April 20. http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/ucm221563.htm.

Fish

Analysis:

55. The DEIS states, "The Western Atlantic stock has suffered a significant decline in spawning stock biomass since 1950, and a 20-year rebuilding plan has failed to revive the population or the North American fishery. The failure of the Gulf of Mexico spawning population to rebuild, as well as the scope of illegal and underreported catches, particularly in the Mediterranean Sea, are of such major concern that the species was recently considered by the Convention for International Trade in Endangered Species for endangered species listing in March 2010." *See* DEIS 4-838.

- According to NOAA, the Bluefin tuna stocks declined starting around 1970.
  - NOAA, FishWatch – U.S. Seafood Facts: Atlantic Bluefin Tuna (*Thunnus thynnus*), Last accessed January 30, 2012, Available at: http://www.nmfs.noaa.gov/fishwatch/species/atl_bluefin_tuna.htm.

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- The motion brought before the Convention for International Trade in Endangered Species in March 2010 did not seek an endangered species listing, but instead sought to ban international trade of Bluefin tuna. It should be noted that this motion did not pass.
  - Gronewold, N., 2009, Is the Bluefin Tuna an Endangered Species?, Scientific American, October 14, Last accessed January 30, 2012, Available at: http://www.scientificamerican.com/article.cfm?id=bluefin-tuna-stocks-threatened-cites-japan-monaco.
- The statement that the motion was brought before the Convention for International Trade in Endangered Species primarily because of the "failure of the Gulf of Mexico spawning population to rebuild" does not appear to have any support. If such statement is supported, a reference should be provided.

56. The DEIS states, "Because of their decline in stock, the timing of their spawn in the Gulf, their buoyant eggs, and the timing of the DWH event, there is concern about further decline in the Gulf stock of Atlantic bluefin tuna. The effects at this time are, however, unknown. Thus far, only anecdotal (observational) evidence is available concerning fish kills. Offshore, a few small fish kills very near the spill site have been reported. On the shelf and inshore also, a few, small fish kills have been reported that included common in shore species such as Atlantic croaker, anchovy, and menhaden." *See* DEIS 4-838.

- This statement should be clarified with the following addition: "Current research suggests that certain fish species may have experienced biological impacts in the short-term, but there is little evidence of a significant decrease in fish populations after the DWH spill. For example, an analysis for NOAA used two independent computer models to show that there is likely less than a 4 percent reduction in future Bluefin tuna spawning because of the DWH oil spill." (Fodrie & Heck 2011, Atlantic Bluefin Status Review Team 2011, Whitehead et al. 2011).
- This statement also should be clarified to note that there may be other causes of fish kills that occur in the Gulf. For example, some of the fish kills in September 2010 in Plaquemines Parish were linked to hypoxia (an annual occurrence in the Gulf due to excess nutrients from the Mississippi River).
- **References:**

  - Fodrie, F. J. and K. L. Heck Jr., 2011, Response of Coastal Fishes to the Gulf of Mexico Oil Disaster, PLOS One 6(7):e21609.
  - Atlantic Bluefin Tuna Status Review Team. 2011. Status Review Report of Atlantic Bluefin tuna (Thunnus thynnus). Report to National Marine Fisheries Service, Northeast Regional Office (May 20, 2011).
  - Whitehead, A., et al. 2011. Genomic and physiological footprint of the Deepwater Horizon oil spill on resident marsh fishes. PNAS. Published online September 26.

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- ○ Associated Press, 2010, Second large fish kill reported in Plaquemines, Last accessed 1/30/2011. http://www.wwltv.com/news/local/PHOTOS-Second-large-fish-kill-reported-in-Plaquemines-103159694.html.

57. The DEIS states, "Although *Corexit 9500*, the dispersant used for the DWH event, is believed to be the least toxic of all of its counterparts to small fish, its toxicity, when mixed with oil, is unknown to specific species of ichthyoplankton, juvenile, and adult fish. In July 2010, USEPA and NOAA proposed a monitoring program that will assess the toxicity of 20:1 oil/*Corexit* to Atlantic silversides. The addition of *Corexit 9500* at the seafloor spill site and the surface resulted in the dispersion of oil in the water column. The addition of any carbon source such as oil can decrease dissolved oxygen due to microbial breakdown, and it was a particular concern during the DWH event due to the use of dispersants (**Chapter 4.2.1.2.1.1**). In areas where plumes of dispersed oil were previously found, dissolved oxygen levels decreased by about 20 percent from long-term average values in the GOM; however, scientists reported that these levels have stabilized and are not low enough to be considered hypoxic (USDOC,NOAA, 2010s). The drop in oxygen, which has not continued over time, has been attributed to microbial degradation of the oil." *See* DEIS 4-838.

   - *Corexit 9500* should be characterized as the least toxic *effective* dispersant.
   - This statement notes that the UEPA and NOAA proposed a monitoring program in July 2010. The EP released a report in September 2010 on the toxicity of various dispersants, including *Corexit*, to silversides and mysid shrimp.
     - ○ USEPA, 2011, EPA's Toxicity testing of Dispersants, Last accessed 1/30/2012. http://www.epa.gov/bpspill/dispersants-testing.html. October 14.
     - ○ USEPA ORD, 2010, Comparative Toxicity of Louisiana Sweet Crude Oil (LSC) and Chemically Dispersed LSC to Two Gulf of Mexico Aquatic Test Species, http://www.epa.gov/bpspill/reports/updated-phase2dispersant-toxtest.pdf. August 31.
   - The statement, "The drop in oxygen, which has not continued over time, has been attributed to microbial degradation of the oil" is incomplete. The drop in oxygen has been significantly attributed to biodegradation of gas (methane), not just oil. Thus, the statement should be rephrased to read, "The drop in oxygen, which has not continued over time, has been attributed to microbial degradation of the oil and gas."

58. The DEIS states, "Very little is really known about the effects of methane on fish." *See* DEIS 4-838.

   - This statement should be more specific as acute effects of methane on fish are well studied and understood.

59. The DEIS states, "Patin (1999) reported elevated concentrations of methane, resulting from gas blowouts from drilling platforms in the Sea of Asov, resulted in significant species-specific pathological changes including damages to cell membranes, organs and tissues, modifications of protein synthesis, and other anomalies typical for the

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acute poisoning of fish. These impacts, however, were observed at levels of 1-10 ml/L. Recently published research (Kessler et al., 2011) revealed that a large amount of methane was released during the DWH event and, based upon the methane and oxygen distributions measured at 207 stations in the affected area, a large amount of oxygen was respired by methanotrophs." *See* DEIS 4-838.

   - "The Patin (1999) study discusses methane concentrations during Sea of Asov field observations as 4-6 ml/L near the well, and 0.07-1.4 ml/L at a distance 200 m from the platform (http://www.offshore-environment.com/gasimpact.html). The cited range of 1-10 ml/L is not based on these field studies but comes from a conceptual diagram describing the "approximate zone of acute toxicity based on a synthesis of studies." The description of the study should be revised to accurately reflect the Patin discussion.
   - "A statement should be added noting that typical methane concentrations observed by Kessler and Joye during the DWH spill were significantly lower than the levels in the Patin (1999) study, with the highest concentrations observed only in the subsea (>799m) near the wellhead. (Valentine et al. 2010).
   - **References:**

     - ○ Patin, S.A. 1999. Environmental impact of the offshore oil and gas industry. East Northpoint, NY: EcoMonitor Publishing. Pp. 425. Also available at: http://www.offshore-environment.com/gasimpact.html.
     - ○ Valentine et al. 2010. Propane Respiration Jump-Starts Microbial Response to a Deep Oil Spill. Science. 330:208-211. October 8.

60. The DEIS states, "Adult fish tend to avoid contact with oil and areas of low dissolved oxygen in the water column (Wannamaker and Rice, 2000)." *See* DEIS 4-839.

   - The citation provided, Wannamaker and Rice (2000), refers to a study testing for the avoidance of areas of low oxygen. This study, however, did not test for the avoidance of oil. Accordingly, the statement should read, "Adult fish tend to avoid contact with areas of low dissolved oxygen in the water column (Wannamaker and Rice, 2000)."

61. The DEIS states, "Although many potential effects of the DWH event on fish populations of the GOM have been alleged, the actual effects are at this time unknown and the total impacts are likely to be unknown for several years." DEIS 2-27; *see also* DEIS 4-321 ("The extent of impacts from the DWH event to EFH and fish resources remains unclear at this time."); 4-323; 4-868.

   - These statements should be revised in light of the fact that OSAT I found no samples exceeding aquatic life benchmarks.
   - Additionally, there has been no evidence to date that Gulf fish populations are significantly affected as a result of the spill. *See, e.g.*, DMR Says Red Snapper Stock is Safe, Biloxi Sun-Herald, (June 14, 2011).

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- Moreover, Fodrie and Heck (2011) suggests no acute impacts to seagrass-associated juvenile fishery stocks occurred as a result of the DWH event.
- In addition, an analysis for NOAA used two independent computer models to show that there is likely less than a 4 percent reduction in future Bluefin tuna spawning because of the DWH oil spill. (Atlantic Bluefin Tuna Status Review Team. 2011).
- Finally, NOAA data shows that the menhaden catch in 2011 was 40.6% higher than the average of the five years previous.
- **References:**
  - DMR Says Red Snapper Stock is Safe, Biloxi Sun-Herald, (June 14, 2011).
  - Fodrie, F. J. and Heck, Jr., K., Response of Coastal Fishes to the Gulf of Mexico Disaster, PLoS One, (July 6, 2011), *available at* http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0021609.
  - Atlantic Bluefin Tuna Status Review Team. 2011. Status Review Report of Atlantic Bluefin tuna (Thunnus thynnus). Report to National Marine Fisheries Service, Northeast Regional Office. (May 20, 2011).
  - NOAA, Status Purse-Seine Landings of Gulf and Atlantic Menhaden for the 2011 Fishing Season, (July 5, 2011), *available at* http://www.st.nmfs.noaa.gov/st1/market_news/doc77.txt.

62. The DEIS states, "Gulf menhaden are of particular concern with respect to the DWH event because they are surface feeders and it is possible that their ingestion of oil may cause population depletion of a major commercial crop. At this time, however, the effect of the DWH event on the commercial menhaden crop is unknown." *See* DEIS 4-301.

- This passage should be revised and updated to reflect recent data showing that the menhaden catch in 2011 was 40.6% higher than the average of the five years previous. (NOAA, Status Purse-Seine Landings of Gulf and Atlantic Menhaden for the 2011 Fishing Season, (July 5, 2011), *available at* http://www.st.nmfs.noaa.gov/st1/market_news/doc77.txt).

63. The DEIS states, "The effects of a catastrophic event, such as the DWH event, on commercial fisheries are preliminary and mostly speculative at this point. Data are unavailable, and it may take several years to acquire then necessary data and analyze it regarding long-term effects of the DWH event on all Gulf of Mexico commercial fisheries populations." *See* DEIS 4-864; *see also* DEIS 4-863.

- This statement should be revised to reflect recent data gathered by the NOAA Fisheries Service and others showing increased catches for several commercial species following the spill through the present.
- **References:**

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  - NOAA, Status Purse-Seine Landings of Gulf and Atlantic Menhaden for the 2011 Fishing Season, (July 5, 2011), *available at* http://www.st.nmfs.noaa.gov/st1/market_news/doc77.txt.
  - NOAA Fisheries Service, May 2011 Shrimp Statistics, *available at* http://www.st.nmfs.noaa.gov/st1/market_news/doc45.txt.
  - DMR Says Red Snapper Stock is Safe, Biloxi Sun-Herald, (June 14, 2011).

64. The DEIS states that "the recreational fishing industry in Texas will be affected to the extent that the fish ecology in the Gulf of Mexico changes due to the spill." DEIS 4-337.

- This statement should be revised to reflect the fact that, to date, there is no evidence of changes to the Gulf fish ecology.

65. The DEIS states that there were "sightings of whale sharks . . . swimming among slicks from the DWH spill." *See* DEIS B-17.

- This statement should be clarified to indicate whether it has been scientifically validated or if it is anecdotal evidence.

Human Health Effects

Analysis:

66. The DEIS states, "To date, there have been no studies of possible long-term health effects for oil-spill cleanup workers. The post-DWH event's human environment remains dynamic, and BOEM will continue to monitor these populations over time and to document short- and long-term DWH event impacts. In the future, the long-term impacts of the DWH event will be clearer as time allows the production of peer-reviewed research and targeted studies that determine those impacts." *See* DEIS 2-65.

- Presently, the National Institute of Health is sponsoring a study by the National Institute of Environmental Health Sciences to monitor the health impacts from the DWH event on oil-spill cleanup workers. This study, known as the Gulf Long-Term Follow-Up (GuLF) Study will continue to monitor these workers for 10 years.
- In addition to the GuLF study, CDC conducted an evaluation of the USEPA air monitoring data and concluded, "The levels of some of the pollutants that have been reported to date may cause temporary eye, nose, or throat irritation, nausea, or headaches, but are not thought to be high enough to cause long-term harm. These effects should go away when levels go down or when a person leaves the area."
- The report does not discuss that several health assessments of worker exposures that were completed while the response was ongoing. NIOSH Health Hazard Evaluation reports are available for a variety of response worker tasks. OSHA also issued a fact sheet statement based on its sampling efforts.

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- Symptoms such as headache, upper respiratory irritation or congestion, nausea, elevated self-monitored blood pressure, fatigue, and chest pain or pressure were reported in some workers. The symptoms were initially attributed to dispersants, but NIOSH investigators later concluded that dispersant use was unlikely to be the cause; instead, unpleasant odors, heat, and fatigue played a significant role (Interim Report #1). NIOSH monitored response workers in different roles (e.g. skimming, decontamination) for VOCs, dispersant compounds, CO, and other compounds, and found that personal and area concentrations were below occupational exposure limits. The NIOSH reports discuss their evaluation of acute health effects (NIOSH 2010).
- "Exposure to any of these hazards depends on what you are actually doing and where you are working. For example, heat stress is a real concern for all outdoor activities because the weather is hot and humid. If you are pulling in oil-covered booms, then contact with weathered oil, drowning, and back injuries are also concerns. Most jobs will only involve contact with weathered oil, which no longer has high levels of hazardous chemicals that can get into the air. To make sure, OSHA is monitoring the air that workers breathe for the hazardous chemicals common in oil and dispersants, as well as other chemicals like carbon monoxide. To date, no air sampling by OSHA has detected any hazardous chemical at levels of concern." (OSHA 2010).
- In response to concerns about airborne exposures to dispersant components (particularly 2-butoxyethanol, a component of Corexit 9527), OSHA noted, "Approximately 80% of the 1048 samples BP analyzed showed 'no detectable level' of 2-butoxyethanol. Of the remaining 20% (n=213) of the samples with any detectable 2-butoxyethanol, the highest level measured was 0.8 ppm, and 90% of these were 0.2 ppm or less. Every measurement was well below the NIOSH recommended limit of 5.0 ppm…. Most exposure measurements found no exposure to the chemical, and all exposure levels detected were well below any occupational exposure limit."

- **References:**

  - National Institute of Occupational Safety and Health, Interim Reports 1-9: Health Hazard Evaluation of Deepwater Horizon Response Workers, (2010), available at http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html
  - Occupational Safety & Health Administration, OSHA Fact Sheet: General Health and Safety Information for the Gulf Oil Spill, (Aug. 19, 2010), http://www.osha.gov/oilspills/deepwater-oil-spill-factsheet-ppe.pdf
  - OSHA, OSHA Statement on 2-Butoxyethanol & Worker Exposure, (July 2010), available at http://www.osha.gov/oilspills/oilspill-statement.html
  - CDC/EPA. 2010. Government Response to the BP Oil Spill. June. http://www.epa.gov/bpspill/reports/odorfactsheet.pdf.

Enclosure 2, *Detailed Technical Comments on 2012-2017 GOM Multisale DEIS*

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67. The DEIS states, "The USEPA released two peer-reviewed reports concerning dioxins emitted during the controlled burns of oil during the DWH event (Aurell and Gullett, 2010; Schaum et al., 2010). . . . The reports found that, while small amounts of dioxins were created by the burns, the levels that workers and residents would have been exposed to were below USEPA's levels of concern." *See* DEIS 4-441.

   - This statement does not give adequate context to the term "small." A clarifying sentence should be added stating that one study estimated the lifetime incremental cancer risks as a result of the DWH at $6x10^8$ for inhalation by workers, $6x10^{12}$ for inhalation by onshore residents, and $6x10^8$ for fish consumption by residents.
     - Schaum, J., M. Cohen, S. Perry, R. Artz, R. Draxler, J.B. Frithsen, D. Heist, M. Lorber, and L. Phillips, 2010, Screening level assessment of risks due to dioxin emissions from burning oil from the BP Deepwater Horizon Gulf of Mexico spill. 21 pp. *Available at* http://www.epa.gov/research/dioxin/docs/OilScreen25.pdf. Also available as: Environ. Sci. Technol. 44(24):9383-9389.

68. The DEIS states, "Modeling tools for the transport and dispersion of air pollutants such as ozone, carbon monoxide, nitrogen dioxide, and PAH's are required to determine the fate and pollutant concentrations in the environment and, subsequently, to assess environmental impacts. It appears that these tools are currently not available for the application to the offshore environment. These tools need to be developed, especially for the long-range transport of air pollutants." DEIS 4-441.

   - This statement is incorrect. Modeling work using some of these tools has been performed to quantify impacts from the DWH event. For example, NOAA used a regional air quality model to estimate the impact of secondary organic aerosol formation and transport on coastal air quality downwind of the spill.
     - Middlebrook, et al., 2011, Air quality implications of the *Deepwater Horizon* oil spill, PNAS, 10.1073/pnas.1110052108.

69. The DEIS states, "[A]t present, a number of scientists, doctors, and health care experts are concerned with the potential public health effects as a result of DWH event in the Gulf of Mexico, and they found that VOC benzene, a cancer causing agent, has been found above Louisiana's ambient air quality standards." DEIS 4-441.

   - This statement is misleading. As an initial matter, the assertion that benzene has been found to be above Louisiana's ambient air quality standards appears to be a comparison of short-term monitoring results taken during the response to Louisiana's annual ambient air quality standard for benzene. As the Louisiana DEQ has noted, however it is inappropriate to compare short-term samples to the annual average standard. Indeed, as of July 13, 2010, Louisiana has not reported any exceedance of state or federal standards as a result of the spill;
     - http://www.deq.state.la.us/portal/LinkClick.aspx?fileticket=zYigIsL2zQA%3D&tabid=2460).

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- http://www.deq.state.la.us/portal/LinkClick.aspx?fileticket=zYigIsL2zQA%3D&tabid=2460).

- While average benzene levels monitored onshore by BP during the spill were higher than historical averages, it is not clear that this elevation is due to the release. Numerous studies have found that nearly all water soluble or volatile oil components (such as benzene) had weathered away from the oil before the oil reached the shoreline. That is, atmospheric and subsurface measurements have indicated that benzene experienced nearly complete dissolution in the water column and was negligible in the evaporative emissions from surface slicks. Effectively no benzene was observed in nearshore oil. There is little potential for public exposure to benzene, given very low levels observed in surface oil.

- **References:**
  - Ryerson, T. B., et al., 2011, Atmospheric emissions from the Deepwater Horizon spill constrain air water partitioning, hydrocarbon fate, and leak rate, Geophysical Research Letters 38:L07803.
  - Middlebrook, et al., 2011, Air quality implications of the *Deepwater Horizon* oil spill, PNAS, 10.1073/pnas.1110052108.
  - Boehm, P.D., et al., 2011, Aromatic Hydrocarbon Concentrations in Seawater: Deepwater Horizon Oil Spill, International Oil Spill Conference, May 23-26, Portland, Oregon, USA.
  - Boehm, P.D., et al., Distribution and Fate of PAH and Chemical Dispersants in the Water Column Following the Deepwater Horizon Oil Spill, SETAC North America 32nd Annual Meeting, November 13-17, Boston, Massachusetts, USA.
  - Gong, C., et al., 2011. The Significant Impact of Weathering on MC252 Oil Chemistry and Its Fingerprinting Camples collected from May to September 2010. Poster Presentation at International Oil Spill Conference, May 23-26, Portland, Oregon.

70. The DEIS states, "To assess the effects of the BP oil spill on human health and the environment, the Institute of Medicine held the workshop, "Assessing the Human Health Effects of the Gulf of Mexico Oil Spill," in New Orleans, Louisiana, on June 22-23, 2010. In this workshop, it has been reported that people in the coastal areas showed the stresses and strains of living with the effects of the spill on their livelihood and their way of life (McCoy and Salerno, 2010). Due to volatile chemicals that evaporated from the oil spill into the atmosphere, people in the coastal areas have been experiencing sickness, fever, coughing, and lethargy. Some of these chemicals can remain in the air for months. These compounds could have significant effects on human health; however, the long-term effects on exposed persons from emissions associated with the DWH event are unknown." See DEIS 4-449.

- Given the significant quantity of data that is available, it is more appropriate for BOEM to assess the health risks from that data rather than relying on statements made during a workshop.

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- The statement "due to the volatile chemicals . . ." presumes causation that has not been substantiated. This statement either should be removed or it should be clarified that USEPA air monitoring data has not identified any pollutants at levels expected to cause long-term health effects and that no relationship between DWH-related chemicals and these anecdotal reports has been established.

- The statement that "[s]ome of these chemicals can remain in the air for months" is misleading. Normal atmospheric conditions would disperse any compounds in air quickly once the source was removed, and many of these compounds also have short half-lives in air due to photochemical breakdown. Any exposures resulting from the spill would have been of limited duration at any particular location.

- As the DEIS states elsewhere, "USEPA monitoring data has so far shown that the use of dispersants during the DWH event did not result in the presence of chemicals that surpassed human health benchmarks (Trapido, 2010)." *See* DEIS B-49.

71. The DEIS states, "Health studies of possible long-term health effects from exposure to either the DWH event's oil or dispersants, such as the possible bioaccumulation of toxins in tissues and organs, are lacking, and the potential for the long-term human health effects are largely unknown (although the National Institutes of Health has proposed such a study)." *See* DEIS 4-421; *see also* 4-441.

- If the study referenced in the final sentence is the National Institutes of Health's GuLF study, then the sentence should be revised to explain that this study commenced in 2010 and is currently at the stage at which participants are being recruited.

- This statement fails to recognize the following factors that caution against a finding of long-term and cumulative health impacts:
  - Worker and shoreline monitoring data indicates that the concentrations of oil and dispersants to which low-income and minority communities were exposed are unlikely to result in adverse health effects. Data from several sources, including OSHA, NIOSH, BP, EPA and the CDC (among others) demonstrate that exposures to DWH oil and dispersants were low and isolated and that there was no evidence of significant on-shore exposure to coastal residents.
  - Seafood closures reduced potential for oil/dispersant exposures through food. NOAA and state agencies implemented fishery closures in waters impacted or potentially impacted by oil, and did not reopen the fisheries until testing indicated that waters were safe for fishing.
  - Extensive seafood safety testing shows virtually all non-detectable levels of PAHs and dispersant compounds.

- **References:**

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- Avens, et al., 2011, Analysis and Modeling of Airborne BTEX Concentrations from the Deepwater Horizon Oil Spill, Environmental Science & Technology, 45:7372-7379.
- BP, 2010 and 2011, Personal Exposure Monitoring Results Summaries, http://usresponse.bp.com/go/doc/2911/963787/Health-monitoring.
- Brown, A. et al. 2011. Monitoring Polycyclic Aromatic Hydrocarbons (PAHs) in Seafood in Mississippi in Response to the Gulf Oil Spill. Gulf Oil Spill SETAC Focused Topic Meeting. Pensacola, Florida. April 26-28. http://gulfoilspill.setac.org/sites/default/files/abstract-book-1.pdf.
- CDC/EPA, 2010, Government Response to the BP Oil Spill, June, Last accessed on January 30, 2012, Available at http://www.epa.gov/bpspill/reports/odorfactsheet.pdf.
- Dickey, 2011, "FDA Risk Assessment of Seafood Contamination after the BP Oil Spill," Environmental Health Perspectives, http://dx.doi.org/10.1289/ehp.1104539R.
- Middlebrook, et al., 2011, Air quality implications of the *Deepwater Horizon* oil spill, PNAS, 10.1073/pnas.1110052108.
- NIOSH, 2011, Deepwater Horizon Response: NIOSH Health Hazard Evaluation. http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html.
- OSHA, 2010, OSHA Fact Sheet: General Health and Safety Information for the Gulf Oil Spill, August 19, Last accessed on January 30, 2012, Available at http://www.osha.gov/oilspills/deepwater-oil-spill-factsheet-ppe.pdf.
- OSHA, 2010, OSHA Statement on 2-Butoxyethanol & Worker Exposure, July, Last accessed on January 30, 2012, Available at http://www.osha.gov/oilspills/oilspill-statement.html.
- OSHA, 2011, OSHA's Efforts to Protect Workers. http://www.osha.gov/oilspills/index.html.
- US Food and Drug Administration. 2011. Deepwater Horizon Oil Spill: Questions and Answers. April 20. http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/ucm221563.htm.
- USEPA, 2011, Monitoring Air Quality Along the Gulf Coast, Last accessed on January 30, 2012, Available at http://www.epa.gov/bpspill/air-mon.html#healtheffects.

72. The DEIS states, "In a catastrophic spill, dispersants may be sprayed to break up the slick. The dispersant mist would temporarily degrade the air quality. Health complaints were received from workers on adjacent rigs following dispersant application during the DWH event." *See* DEIS 4-441.

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- The discussion suggests that during the response to the DWH event, dispersant use impaired air quality and led to health complaints. This statement should be revised in light of NIOSH investigators' conclusion that dispersant use was unlikely to be the cause of health complaints, and the fact that occupational monitoring identified no instances of personal or area concentrations exceeding occupational exposure limits.
- This section should discuss data compiled related to worker and offshore monitoring, which identified no evidence of exposure to dispersant components at or above levels of concern.
- The discussion notes that "health complaints were received." A citation for the source of this statement should be added and the discussion expanded to note that (1) it is not clear whether any such allegations were directly linked to dispersants; (2) dispersants were not applied near rigs or vessels; (3) industrial hygiene monitoring found no evidence of worker exposures of concern; and (4) EPA monitoring along the shoreline also found no evidence of exposures of concern.
- In response to concerns about airborne exposures to dispersant components (particularly 2-butoxyethanol, a component of Corexit 9527), OSHA noted, "Approximately 80% of the 1048 samples BP analyzed showed 'no detectable level' of 2-butoxyethanol. Of the remaining 20% (n=213) of the samples with any detectable 2-butoxyethanol, the highest level measured was 0.8 ppm, and 90% of these were 0.2 ppm or less. Every measurement was well below the NIOSH recommended limit of 5.0 ppm . . . . Most exposure measurements found no exposure to the chemical, and all exposure levels detected were well below any occupational exposure limit."
- **References:**

  - Middlebrook, et al., 2011, Air quality implications of the *Deepwater Horizon* oil spill, PNAS, 10.1073/pnas.1110052108.
  - National Institute of Occupational Safety and Health, Interim Reports 1-9: Health Hazard Evaluation of Deepwater Horizon Response Workers, (2010), available at http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html.
  - Occupational Safety & Health Administration, OSHA Fact Sheet: General Health and Safety Information for the Gulf Oil Spill, (Aug. 19, 2010), http://www.osha.gov/oilspills/deepwater-oil-spill-factsheet-ppe.pdf.
  - OSHA, OSHA Statement on 2-Butoxyethanol & Worker Exposure, (July 2010), available at http://www.osha.gov/oilspills/oilspill-statement.html.

73. The DEIS states, "Avens et al. (2011) analyzed airborne BTEX concentrations from the DWH event and found that 99 percent of their measurements taken prior to capping the well were lower than OSHA's permissible exposure limits for BTEX." *See* DEIS 4-421.

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- This statement should be expanded to state, "Avens et al. attribute the airborne BTEX concentrations that were measured during worker exposure monitoring to boat engine emissions."

74. The DEIS discusses U.S. poison control center exposure calls involving physical exposure to an oil-spill-related toxin (*e.g.*, oil, dispersant, food contamination, or other associated toxin) and information calls from persons with questions about the medical impact of the DWH event. It also discusses Tulane University's Disaster Resilience Leadership Academy's door-to-door health and economic impact survey in coastal Louisiana, in response to which large numbers of residents reported exposure to oil or dispersant, and perceived symptoms associated therewith. *See* DEIS 4-960.

    - Results of EPA, NIOSH, and OSHA monitoring all indicate that there have been no exposures to oil-spill-related toxins at levels of concern. Use of quantitative monitoring results is more meaningful than reported health effects that may be due to a number of causes other than the DWH release.
    - *See also* comments 68 to 70.

75. The DEIS states, "Longitudinal epidemiological studies of possible long-term health effects from exposure to either the DWH oil spill or dispersants, such as the possible bioaccumulation of toxins in tissues and organs, are lacking and the potential for the long-term human health effects are largely unknown (although the National Institutes of Health has proposed such a study)." *See* DEIS B-49.

    - If the proposed study by the National Institutes of Health refers to the GuLF study, then the sentence should be revised to explain that this study commenced in 2010 and is currently at the stage at which participants are being recruited.

Marine Mammals

76. The DEIS states, "It is therefore unclear whether increases in stranded cetaceans during and after the DWH-event response period are or are not related to impacts from the DWH event, and it will likely remain unclear until NMFS completes its UME and NRDA evaluation processes." *See* DEIS 4-192.

    - This discussion should be revised to reference the recent finding that brucellosis, a bacterial infection, was the cause of death for approximately 25% of the dolphins necropsied as part of NOAA's investigation of the UME.
    - **References:**
        - NOAA Fisheries Service, NOAA finds bacterial infection as cause of death for five northern Gulf dolphins; investigation continues (Oct. 27, 2011), *available at* http://www.nmfs.noaa.gov/stories/2011/10/27_dolphin_bacterial_infection_caues_dolphin_death.html.

API 2 COMMENTS 77-82

77. The DEIS states, "The DWH event in Mississippi Canyon Block 252 and resulting oil spill and related spill-response activities (including the use of dispersants) have impacted marine mammals that have come into contact with oil and remediation efforts. According to the Dolphins and Whales of the Gulf of Mexico Oil Spill website, within the designated DWH spill area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 Kogia spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NMFS, 2011b)." *See* DEIS 4-193; *see also* DEIS 4-210; 4-699; 4-712; 4-717.

    - As written, this statement may imply that these mortalities represent confirmed impacts from the DWH event. However, these dolphin strandings have not been linked with the DWH event, and a UME was in progress prior to the spill. These statements should be clarified accordingly.

78. The DEIS states, in reference to the UME, that "a vast majority of these strandings involving premature, stillborn, or neonatal bottlenose dolphins." *See* DEIS 4-699.

    - The strandings data, which shows approximately 115 premature, stillborn, or neonatal bottlenose dolphins out of over 500 total bottlenose dolphins identified during the UME, do not support this statement. Thus, this language should be deleted.

79. The DEIS states that the cause of the UME "will likely remain unclear until NMFS completes its UME and NRDA evaluation processes." *See* DEIS 4-699.

    - The causes of UMEs are often undetermined. This clarification should be noted.

80. The DPEIS states, "Due to known low detection rates of carcasses, it is possible that the number of deaths of marine animals is underestimated (Williams et al. 2011)." *See* DEIS at 4-699; *see also* DEIS 4-712.

    - The cited publication acknowledges that the unprecedented effort by government agencies and others to search for marine mammal carcasses after the spill may have raised carcass recovery rates significantly above the levels found in normal circumstances. The statement should be revised or supplemented to note this conclusion.

81. The DEIS states, "There were 171 marine mammals collected as of April 20, 2010 (the majority of which were deceased)." *See* DEIS B-35.

    - This appears to be a typographical error. The correct date is April 20, 2011.

82. The DEIS states, "According to the NMFS website's reports on stranded marine mammals during and after the DWH event, 171 marine mammals (the majority of which were deceased) have been collected as of April 20, 2011." *See* DEIS 4-204.

    - A citation to the data on the NMFS website should be provided.

API 2 COMMENTS 82-84

- This statement should include the following caution, "According to the NMFS website, all data should be considered preliminary until all necropsies have been performed. Data is continually being updated. Brucellosis is considered a possible cause of the mortalities."

83. The DEIS states, "It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that not all carcasses were related to the DWH oil spill. The blowout of the *Ixtoc I* offshore rig in the Bay of Campeche, Mexico, on June 3, 1979, resulted in the release of 500,000 metric tons (140 million gallons) and the transport of this oil into the Gulf of Mexico (ERCO, 1982). Three million gallons of oil impacted Texas beaches (ERCO, 1982). According to the ERCO study, 'Whether or not hypoxic conditions could, in fact, be responsible for area-wider eductions in [invertebrate] faunal abundance is unclear, however.' Therefore, the effects from the *Ixtoc* spill on marine mammals in waters off Texas are largely unknown." *See* DEIS 4-205.

- The statement, "[t]hree million gallons of oil impacted Texas beaches" should be revised to state "One to three million" to be consistent with the ERCO reference.
- After statement, "it is possible that not all carcasses were related to the DWH oil spill," a note should be added that states "Hypoxic conditions were not observed post-DWH."
- ERCO does not suggest that hypoxic conditions were the result of the spill. They were normal Gulf of Mexico summer dead zone conditions.
- **References:**
  - Operational Science Advisory Team (OSAT), 2010, Summary report for sub-sea and sub-surface oil and dispersant detection: Sampling and monitoring, Unified Area Command, New Orleans, LA, Released on December 17, 2010.

84. The DEIS states, "during and following the DWH event and response, two sperm whales have been documented as oiled within the DWH affected area (USDOC,NMFS, 2011b). It is yet unknown whether the DWH event was the cause of death for these two individuals." *See* DEIS 4-699; *see also* DEIS 4-700; 4701.

- The sentence, as written, suggests that the whales were found dead where oiled, which is not supported by the source cited. This discussion should be revised to read: "two dead sperm whales have been documented within the affected area, but the cause of death for these two whales is still unknown."
- An additional citation should be included to a source from the same website, showing that a total of three non-dolphin marine mammals were spotted dead, two of which were not visibly oiled and one with a pending oiling status (http://www.nmfs.noaa.gov/pr/health/oilpsill/mammals.htm).

Oil Spill Trajectory/Fate and Transport of Oil

Analysis:

API 2 COMMENTS 85-88

85. The DEIS states, "Lubchenco et al. (2010) estimated that 26 percent of the total spill volume remained at large in the GOM shortly after the Macondo well was capped on July 16, 2010, and at least some portion of that has probably settled onto the GOM deepwater seafloor." *See* DEIS 4-124.

- The sentence should be revised to reflect that the well was capped on July 15, 2010, not July 16, 2010.
- This discussion should be revised to account for the quantitative discussion of OSAT and other sediment data, which generally indicated a lack of sediment impact outside the area immediately surrounding the wellhead. It should also note that further sampling and analysis of sea floor sediments are underway.
- The discussion as currently written suggests that the 26 percent of oil that was not described by the oil budget remained in the Gulf of Mexico. The Oil Budget, which is response-focused, is not an accurate analysis of long-term oil fate and this sentence should be revised to provide clarity on that point.
- The discussion should be revised to remove the suggestion that oil has probably settled on the seafloor and include quantitative discussion of oil settling in OSAT and other sediment data. As noted in comment 100 (Sediments) below, OSAT-1 shows a lack of sediment impact outside the area immediately surrounding the wellhead.

86. "In situations where soft-bottom infaunal communities were negatively impacted, recolonization by populations from neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms, i.e., a matter of days for bacteria and probably less than 1 year for most macrofauna and megafauna species (Lu and Wu, 2006; Netto et al., 2009; Santos et al., 2009). This could take longer for areas affected by direct oil contact in higher concentrations." *See* DEIS 4-124.

- There does not appear to be any discussion that recolonization could be expected in "a matter of days for bacteria" in the sources cited. Therefore, either a citation should be added or this language removed.

87. The DEIS states, "The DWH event released an estimated 4.9 million bbl of oil into the water over an 87-day period following the event." *See* DEIS 4-632; *see also* DEIS G-32.

- This statement should read that "4.1 bbl of oil" was estimated to be released into the water. An additional 0.8 million bbl were collected during the response and not released into the water.

88. The DEIS states, "Since oil plumes would be carried by underwater currents, the impacts would be distributed in a line from the source toward the direction that the water currents travel." *See* DEIS 4-639.

API 2 COMMENTS 88-91

- Information from Valentine et al. 2012 (PNAS), which indicates that subsurface currents did not move oil in a linear fashion, should be reviewed and this statement updated accordingly.
- **References:**
  - Valentine et al. 2012. Dynamic autoinoculation and the microbial ecology of a deep water hydrocarbon irruption. PNAS Early Release. doi: 10.1073/pnas.1108820109. Published Online January 10.

89. The DEIS states, "As well, a subsurface oil and gas plume was discovered in the deep waters between ~1,100 and 1,300 m (3,609 and 4,265 ft) (e.g., Diercks et al., 2010)." *See* DEIS 4-465.

- This statement should be revised to clarify that there are no longer any detectable PAHs in the Gulf of Mexico as a result of the spill, and there have not been since August 2010.

90. The DEIS states, "As a result of the use of subsea dispersants and natural dispersion, subsurface plumes of dispersed oil would likely occur near blowout sites in deep, offshore waters." *See* DEIS 4-465.

- This statement should reference and discuss the findings of the 2004 SINTEF DEEPSPILL study, which indicates that subsea dispersed plumes would also result from physical dispersion caused by a high energy subsea release, and therefore, while chemical dispersants may have contributed to the amount of oil dispersed in the deep subsea, they were not the sole cause of the "plumes."
- **References:**
  - Adams, E. E. and S. A. Socolofsky, 2004 (revised 2005), Review of Deep Oil Spill Modeling Activity Supported by the DeepSpill JIP and Offshore Operators Committee, DeepSpill JIP and Offshore Operators Committee.

91. The DEIS states, "The National Academy of Sciences (NRC, 2003), Patin (1999), and Boesch and Rabalais (1987) have reviewed the fate and effects of spilled oil and, to a lesser degree, natural gas releases. **Chapters 3.2.1.5 and 3.2.1.6** present the risk of offshore spills associated with a proposed action. Oil spills at the water surface may result from a platform accident. Subsurface spills are more likely to occur from pipeline failure or a loss of well control. As noted above, the behavior of a spill depends on many things, including the characteristics of the oil being spilled as well as oceanographic and meteorological conditions. An experiment in the North Sea indicated that the majority of oil released during a deepwater blowout would quickly rise to the surface and form a slick (Johansen et al., 2001). In such a case, impacts from a deepwater oil spill would occur at the surface where the oil is likely to be mixed into the water and dispersed by wind and waves. The oil would undergo natural physical, chemical, and biological degradation processes including weathering. However, data and observations from the DWH event challenged the previously prevailing thought that most oil from a deepwater blowout would quickly rise to the surface. Measurable amounts of hydrocarbons (dispersed or otherwise) were detected

API 2 COMMENTS 91-93

in the water column as subsurface plumes and on the seafloor in the vicinity of the release (e.g., Diercks et al., 2010;OSAT, 2010). After the *Ixtoc* blowout in 1979, which was located 50 mi (80 km) offshore in the Bay of Campeche, Mexico, some subsurface oil also was observed dispersed within the water column (Boehm and Fiest, 1982); however, the scientific investigations were limited (Reible, 2010). The water quality of offshore waters would be affected by the dissolved components and oil droplets that are small enough that they do not rise to the surface or are mixed down by surface turbulence. In the case of subsurface oil plumes, it is important to remember that these plumes would be affected by subsurface currents and could be diluted over time. Even in the subsurface, oil would undergo natural physical, chemical, and biological degradation processes including weathering." *See* DEIS 4-470

- The discussion of weathering and biodegredation of the subsurface plume should be expanded to discuss Reddy, et al., 2011. This study notes that petroleum hydrocarbons had a degradation half-life of approximately one month, while gas and n-alkanes had a half-life of around two days. This study suggests that biodegredation likely rapidly depleted the subsurface dispersed oil once the release was stopped.
- **References:**
  - Reddy, et al., 2011, Composition and fate of gas and oil released to the water column during the Deepwater Horizon oil spill, Proceedings of the National Academy of Sciences (PNAS), 10.1073/pnas.1101242108.

92. The DEIS states, "The Macondo oil weathered as it traveled to the sea surface, floated on the sea surface, and traveled in the subsea plume; and it became depleted in lower molecular weight PAH's (which are the most acutely toxic components) (Brown et al., 2010; Eisler, 1987)." *See* DEIS 4-564.

- The sentence as currently written implies that weathered oil traveled from the surface back into the subsea plume. The sentence should be revised to discuss how oil weathered as it traveled to the surface (where it continued to weather) or instead stayed in the subsea plume and weathered there as well.

93. The DEIS states, "In its August 2010 assessment, the National Incident Command (NIC) estimated that half of the oil was removed from the water column either by direct recovery, by burning or skimming, or by evaporation and dissolution. Another 24% was dispersed. About 26% of the oil (an estimated 1.3 Mbbl) remained on or near the water surface, or was deposited onshore, or buried in sand and sediments. The Georgia Sea Grant Oil Spill Update, published on August 17, 2010, estimated that between 70 and 79% (2.9 and 3.2 Mbbl) of the oil spilled during the 2010 DWH event remains at or below the water surface. It recommended further assessment of dispersed and dissolved forms of oil to determine its potential threat to the ecosystem because such forms of oil remain highly toxic (Hopkinson 2010)." *See* DEIS G-32.

- This discussion should note that these estimates are as of August 2010, and that much of the oil has been weathered since that time.

API 2 COMMENTS 93-95

- This discussion should note that the last recoverable surface oil was identified in August 2010, and by mid-October 2010, the FOSC said the highest concentrations seen in the water column were about 0.5 ppb. (http://www.restorethegulf.gov/release/2010/10/19/transcript-operational-update-fosc-rear-adm-paul-zukunft).
- This discussion should note that there is an ongoing investigation as to how much of the oil remains in the environment.
- This discussion should note that much of the oil reported by Georgia Sea Grant to remain in the environment was dissolved or dispersed and not recoverable by response methods.
- This section should note that the discrepancy between the NIC and Georgia Sea Grant estimates is due to the fact that the NIC estimate focused only on recoverable oil.
- This discussion should discuss and cite to Ryerson, et al. 2011b, which provides estimates of the distribution of the DWH hydrocarbon fate in the air, surface, and subsurface.

Recreation

Analysis:

94. The DEIS states, "During hot, sunny days, tarballs buried near the surface of the beach sand may liquefy and cause a seep to the sand surface." *See* DEIS 4-493.

- This discussion should note that while tarballs can liquefy in hot weather, it is unlikely they would "cause a seep" given their consistency and tendency to stick to sand particles.

Seafood

95. The DEIS states, "Actual levels of exposure [to contaminated seafood] are unknown as are the potential health effects from higher than expected exposure, but State and local health monitoring and Federal health studies are either ongoing or in the proposal phase (Mackar, 2010)." *See* DEIS 4-960.

- This statement does not acknowledge the extensive water, sediment, and seafood sampling that has been performed by state and federal agencies and BP.
  - For example, from an abstract reporting the results of over 250 seafood samples analyzed by the state of Mississippi since the end of May 2010: "PAHs have not been detected in any sample collected to date at levels above the Level of Concern (LOC) as established in the reopening protocol. PAHs were routinely detected in most samples at low part-per-billion levels and are

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API 2 COMMENTS 95-96

consistent with values commonly detected in samples measured in other studies unrelated to the oil spill." (Brown et al. 2011).

  - For example, FDA prepared a Questions and Answers page that reported the following: "Most of the seafood samples tested had no detectible oil or dispersant residue. For the few samples in which some residue was detected the levels were far lower than the amounts that would cause a health concern, even when eaten on a daily basis. When oil residue was found, the levels were 100 to 1,000 times lower than the levels of concern. In the 1% of samples in which dispersant was detected, the levels were more than 1,000 times lower than the levels of concern. To better understand what this means, the Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Health and Hospitals calculated the amount of seafood the average person could eat, each day, for 5 years, based on the actual contamination levels, without there being a health concern from the oil. A person could eat, each day, the following: 63 lbs of peeled shrimp (1,575 jumbo shrimp); OR 5 lbs. of oyster meat (130 individual oysters); OR 9 lbs. of fish (18 8-ounce fish filets)." (FDA 2011).

- **References:**

  - Brown, A. et al. 2011. Monitoring Polycyclic Aromatic Hydrocarbons (PAHs) in Seafood in Mississippi in Response to the Gulf Oil Spill. Gulf Oil Spill SETAC Focused Topic Meeting. Pensacola, Florida. April 26-28. http://gulfoilspill.setac.org/sites/default/files/abstract-book-1.pdf.
  - US Food and Drug Administration. 2011. Deepwater Horizon Oil Spill: Questions and Answers. April 20. http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/ucm221563.htm.

96. The DEIS states, "In Gulf coastal areas, low-income and minority groups are heavy subsistence users of local seafood. The concern is that heavy subsistence users face higher than expected, and potentially harmful, exposure rates to PAH's from the DWH event." *See* DEIS 4-422; *see also* DEIS 4-428; 4-960.

- This statement does not mention the results of federal or state seafood sampling, which show that Gulf seafood is safe for human consumption, even in large amounts.
- An FDA study stated that the seafood consumption numbers used in its risk assessment were conservative because they were based on National Health and Nutrition Examination Survey 90th percentile consumption data.
- FDA prepared a Questions and Answers page that reported the following: "Most of the seafood samples tested had no detectible oil or dispersant residue. For the few samples in which some residue was detected the levels were far lower than the amounts that would cause a health concern, even when eaten on a daily basis. When oil residue was found, the levels were 100 to 1,000 times lower than the levels of concern. In the 1% of samples in which dispersant was detected, the

API 2 COMMENT 96

levels were more than 1,000 times lower than the levels of concern. T o better understand what this means, the Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Health and Hospitals calculated the amount of seafood the average person could eat, each day, for 5 years, based on the actual contamination levels, without there being a health concern from the oil. A person could eat, each day, the following: 63 lbs of peeled shrimp (1,575 jumbo shrimp); OR 5 lbs. of oyster meat (130 individual oysters); OR 9 lbs. of fish (18 8-ounce fish filets)." (FDA 2011).

- From an abstract reporting the results of over 250 seafood samples analyzed by the state of Mississippi since the end of May 2010: "PAHs have not been detected in any sample collected to date at levels above the Level of Concern (LOC) as established in the reopening protocol. PAHs were routinely detected in most samples at low part-per-billion levels and are consistent with values commonly detected in samples measured in other studies unrelated to the oil spill." (Brown et al. 2011).
- **References:**
  - Brown, A. et al. 2011. Monitoring Polycyclic Aromatic Hydrocarbons (PAHs) in Seafood in Mississippi in Response to the Gulf Oil Spill. Gulf Oil Spill SETAC Focused Topic Meeting. Pensacola, Florida. April 26-28. http://gulfoilspill.setac.org/sites/default/files/abstract-book-1.pdf.
  - Dickey, 2011, "FDA Risk Assessment of Seafood Contamination after the BP Oil Spill," Environmental Health Perspectives, http://dx.doi.org/10.1289/ehp.1104539R.
  - US Food and Drug Administration. 2011. Deepwater Horizon Oil Spill: Questions and Answers. April 20. http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/ucm221563.htm.
- Additional Resources to Consider:
  - NOAA Fishery Closure Maps, *available at* http://sero.nmfs.noaa.gov/ClosureInformation.htm; Seafood Fishing and Monitoring Data *available at* http://www.noaa.gov/deepwaterhorizon/data/seafood_safety.html; FDA, Deepwater Horizon Oil Spill: Questions and Answers. April 20 (2011), *available at* http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/ucm221563.htm.
  - Abstract, Brown, A. *et al*, Monitoring Polycyclic Aromatic Hydrocarbons (PAHs) in Seafood in Mississippi in Response to the Gulf Oil Spill, Gulf Oil Spill SETAC Focused Topic Meeting. Pensacola, Florida. April 26-28, 2011, *available at* http://gulfoilspill.setac.org/sites/default/files/abstract-book-1.pdf.

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Sea Turtles

API 2 COMMENTS 97-98

97. The DEIS discusses the fact that the cause of death of turtles collected following the spill has not yet been determined. *See, e.g.*, DEIS 4-227; 4-249; 4-734; 4-735; B-19.

- This statement should be revised to incorporate information from NOAA suggesting that many of the sea turtles collected may have been killed in fishing operations.
  - The most recent Deepwater Horizon Response Consolidated Fish and Wildlife Collection report (dated April 20, 2011) states that 456 live, visibly oiled sea turtles have been collected along with 80 live turtles without visible evidence of oiling. Of the 613 dead sea turtles collected, only 18 showed visible evidence of oiling, 517 showed no visible evidence of oiling, and 78 cases remain pending (USFWS 2011).
  - "A number of the necropsies conducted on sea turtles with no visible evidence of oil have suggested that they may have drowned by being caught in fishing nets, unable to ascend to the surface to breath. Necropsy results have been shared with state and federal enforcement officials who have stepped up efforts to prevent turtles from being incidentally captured and killed in fishing operations." (NOAA).
- **References:**
  - US Fish and Wildlife Service. 2011. Deepwater Horizon Response Consolidated Fish and Wildlife Collection Report. April 20. http://www.fws.gov/home/dhoilspill/pdfs/ConsolidatedWildlifeTable042011.pdf.
  - NOAA. Probing the Deaths of Sea Turtles in the Gulf of Mexico http://www.noaa.gov/deepwaterhorizon/news/pdf/deathseaturtles.pdf.
  - John Collins Rudolf, "On Our Radar: Fishing Nets Killed More Turtles than BP Oil, Official Says," NY Times (Dec. 29, 2010), available at http://green.blogs.nytimes.com/2010/12/29/on-our-radar-fishing-nets-killed-more-turtles-than-bp-oil-official-says/.

Sediments

Analysis:

98. The DEIS discusses data concerning oil on bottom sediments and its effect on benthic communities from various spills, including the Chevron Main Pass spill, the *Ixtoc* spill, and the DWH event. *See* DEIS 4-161.

- A direct comparison of the *Ixtoc* and DWH events is scientifically questionable given significant differences in spill conditions including, importantly, release depth (which affects the apportionment of oil to the seafloor).

API 2 COMMENTS 98-100

- This discussion may need to be revised to acknowledge the inconsistencies between the cited documents. For example, if 1 g/m2 of oil was estimated as having sunk to the seafloor, but surface sediment samples did not detect any hydrocarbons, then either the 1 g/m2 estimate was refuted by the 1982 ERCO findings or there are methodological limitations in the sampling and the estimates from Jemelov and Linden (1981).
- The statement, "This data show that the oil may take some time to reach the seafloor and when it does, it is widely dispersed. This situation could vary, however, depending on the characteristics of the oil and whether or not dispersants are used," should also reference local topography and depth of release as additional factors potentially affecting sedimentation.
- The conclusion that "resultant low-level, widespread concentrations of oil on the seafloor occurred with the DWH event" is not supported by the DWH sampling data that find that no measurable hydrocarbon impact is to be expected from the DWH event. Indeed, because of oil characteristics, dispersion, weathering, and other factors, oil concentrations on the seafloor are expected to be below detectable thresholds, as generally confirmed by OSAT data.

99. The DEIS includes a discussion of weathering of sedimented oil. *See* DEIS 4-176 to 4-177.

- The statement, "Sedimented oil may travel great distances from the spill site and could be deposited 1-2 years following the spill (Suchanek, 1993)," should be clarified to be consistent with later statements in this section and avoid implying that the same extent of oil impacts that occurred during the spill would continue for 1 to 2 years. A statement should be added, "Any such later deposited sedimented oil would be significantly less toxic and degraded by that time." (Ganning et al. 1984).
- The statement, "The sedimentation process results in the loss of a majority of the more toxic hydrocarbons from the oil (Moore, 1976)" implies that the sedimentation processes, such as adherence or settling, reduce toxicity. However, it is the biodegradation and dissolution processes that result in the loss of the more toxic hydrocarbons. These processes may occur while particles settle out or remain suspended in the water column.
- **References:**
  - Ganning, B., D.J. Reish, and D. Straughan, 1984, Recovery and restoration of rocky shores, sandy beaches, tidal flats, and shallow subtidal bottoms impacted by oil spill. In: Cairns, J., Jr. and A.L. Buikema, Jr., eds. Restoration of habitats impacted by oil spills. Boston, MA.

100. The DEIS states, "Depending on how long it remained in the water column, oil may have been thoroughly degraded by biological action before contact with the seafloor. Water currents could have carried a plume to contact the seafloor directly but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; ITOPF, 2002). Oil also would have reached

API 2 COMMENTS 100-102

the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Distribution of the dispersed oil was dictated by water currents and the physical processes of dispersion and degradation. These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010)" *See* DEIS 4-123; *see also* DEIS 4-655 (stating "Dispersant reduces the oil's ability to adhere to particles in the water column, slowing its rate of precipitation to the seafloor . . . and oil droplets remain neutrally buoyant in the water column, creating a subsurface plume of oil . . . . These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action that would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment.").

- This discussion should reference data from OSAT showing no evidence of measurable oil impact to the deep sea floor at distances greater than 3 km from the wellhead and suggesting that oil impacts closer to the well are the result of entrainment with drilling mud. There is no evidence to support the conclusion that subsurface dispersed oil later contacted the sea floor.
- The phrase "small amounts of oil" should be revised to be more explicit in light of available data examining the fact that oil concentrations reduced very rapidly by dissolution, dilution, and biodegredation.
- The use of the term "scattered microhabitats" suggests that bacteria are very limited in some areas, which is not suggested by Hazen.
- A similar paragraph appears in the DEIS at 4-140 and should be revised to both include the references to biodegredation in Hazen, et al., 2010 and remove the assumptions about sea floor settling that are not supported by the data contained in OSAT.
- **References:**
  - Operational Science Advisory Team (OSAT), 2010, Summary report for sub-sea and sub-surface oil and dispersant detection: Sampling and monitoring, Unified Area Command, New Orleans, LA, Released on December 17, 2010.

101. The DEIS states, "As of this writing, there are no data on the concentrations of hydrocarbons in sediments or on benthic community structure on the sea floor of the Gulf of Mexico after this event." *See* DEIS 4-124.

- This discussion should be revised to account for the analysis of sediment samples and hydrocarbon and dissolved oxygen levels discussed in OSAT-1, JAG and BP data.

102. The DEIS states "Joye (2010) reports observation of sea floor conditions that appear to be sedimented oil in the area around the DWH event site (Harris, 2010)." *See* DEIS 4-124.

API 2 COMMENTS 102-105

- The discussion should note that no Joye report is currently available and that Joye's conclusion that there are impacted sediments 40 miles from the wellhead are directly contradicted by the OSAT report, which discusses governmental sampling in the same area that identified no oil in sediments.
- The discussion should also note that Joye has since publicly revised her conclusions (see comments at February 19, 2011 AAAS meetings) and now hypothesizes that sediment changes are the result of bacteria community changes, rather than large-scale oil sedimentation.

103. The DEIS states, "No dispersants were detected in sediment on the Gulf floor (OSAT, 2010)." *See* DEIS 4-90.

- The three summary tables in OSAT 2010 show a total of 8 detected dispersant samples in the sediment. Map 7.8 in OSAT 2010 also shows dispersant detection in the sediment of the Gulf floor. The sentence should be revised to say "8 dispersant detections out of 776 sediment samples."

104. The DEIS states, "It is not yet known how much oil sedimented to particles and settled to the seafloor. If large amounts of oil made its way to the seafloor, the underlying benthic communities may have been smothered by the particles or exposed to toxic hydrocarbons." *See* DEIS 4-665.

- The implication that "large amounts of oil" may have made their way to the sea floor, exposing benthic communities to "toxic hydrocarbons" should be revised in light of subsequent text, which acknowledges that "Only 7 samples of the 388 samples collected in the offshore zone . . . were determined to have the Mississippi Canyon Block 252 signature and exceeded the USEPA chronic aquatic life benchmark (OSAT, 2010)." *See* DEIS 4-666.

Shoreline

Analysis:

105. The DEIS states, "The DWH event was the largest spill recorded in the GOM and resulted in the oiling of an extensive portion of the Gulf Coast shoreline from east of the Texas/Louisiana State line to northwest Florida. This event must be considered in the cumulative baseline due to the volume of oil released and the geographic area affected. However, unlike other historic large spills (*Exxon Valdez* and *Ixtoc*), the oil was released and treated in deep water nearly 97 km (60 mi) from shore, and the spill occurred in an unconfined open ocean as opposed to a sheltered embayment." *See* DEIS 4-517.

- This statement should be rewritten to include estimates of oiled shoreline distance from SCAT surveys, instead of using the more general "extensive portion" language, which could be read to incorrectly imply that a majority of the shoreline between Texas and Florida was oiled, which is not correct.
- The DWH release occurred 49 miles from shore, not 60 miles.

API 2 COMMENTS 106-108

106. The DEIS states, "as of January 2011, oiling was still present on many shorelines and on barrier islands." *See* DEIS G-32.

- This statement should be revised to read "some" instead of "many," because "many" gives the impression that much of the shoreline is still oiled.

107. The DEIS characterizes the DWH even as having deposited oil "along most of the Gulf Coast shoreline from the Louisiana/Texas State line to the Florida beaches as far east as Panama City, Florida." *See* DEIS 4-49 to 4-50.

- It is incorrect to say that "most" of this shoreline was oiled. The Louisiana shoreline alone is more than 7,000 miles in total. Moreover, NOAA data on maximum surface oiling conditions in Louisiana, Mississippi, Alabama, and Florida indicate that no oil was ever observed in 3,160 miles out of the 4,216 miles surveyed as of February 27, 2011.
- **References:**
    - http://www.census.gov/compendia/statab/2011/tables/11s0360.pdf.
    - Rutherford 2011, ftp://ftp.orr.noaa.gov/public/ERD/Apr_5-7-2011_SOS_Presentations_1/Apr_5-7-2011_DWH_Presentations/DWH_SCAT_Status.pdf.

108. The DEIS states, "If they do reach shore, only light localized impacts to inland wetlands would occur. The wetland areas affected by the DWH event, with the possible exception of extremely heavily oiled areas (Bay Jimmy), have already shown signs of recovery through new shoot production and plant growth (White, official communication, 2010). In the heavily oiled areas (Bay Jimmy), it is still too early to determine the amount of recovery until sampling and analysis have been completed for an entire growing season. Initial sampling and analysis in both offshore and nearshore areas affected by the DWH event have been completed by NOAA and OSAT. These preliminary analyses support that the offshore spills become weathered and are reduced in toxicity in most cases. Three types of oil residue (supratidal buried oil, small surface residue balls, and submerged oil mats) were examined and evaluated in a report prepared by OSAT (2010) and submitted to the Gulf Coast Incident Management Team. Their findings indicated that the oil residues were well weathered and showed a 86- to 98-percent depletion of total PAH's. The OSAT report also noted that, due to the effects of weathering, biodegradation, and the location of the buried oil, there would be a minimal risk of leaching from supratidal buried oil. Based on modeling information, PAH concentration of buried oil in most locations will decrease by 20 percent within 5 years. In some isolated conditions, the PAH's could persist longer (OSAT-2, 2011). If any inland spills occur, they would likely be small and at inland service bases or other support facilities and generally located away from wetlands; therefore, the spills would not be expected to affect wetlands." *See* DEIS 4-519.

- The citation to "OSAT (2010)" should be changed "OSAT-2, 2011."

API 2 COMMENTS 108-113

- In the sentence beginning "Based on modeling information. . . ," the phrase "buried oil" should be replaced with "supratidal buried oil," which is what OSAT references.

109. The DEIS states, "Potential for resuspension and transport of oil from the DWH event exists as a result of heavy vessel traffic or dredging in areas previously oiled." *See* DEIS 4-483 to 4-484.

- This statement should be revised to clarify that, with the exception of limited residual nearshore oiling in the form of submerged oil mats, there is little potential for resuspension and transport of DWH oil by vessel traffic.
- This statement should note that the OSAT II report found that no evidence of human health risks associated with buried oil and noted "that the environmental effects of the residual oil remaining after cleanup are relatively minor, especially when considered in the context of pre-spill background of shoreline oiling." (p. 33) (OSAT II 2011).
- **References:**
  - OSAT-2 (Operational Science Advisory Team), 2011, Summary Report for Fate and Effects of Remnant Oil in the Beach Environment, prepared by Operational Science Advisory Team Gulf Coast Incident Management Team for Lincoln D. Stroh, CAPT, U.S. Coast Guard, Federal On-Scene Coordinator, Deepwater Horizon MC252, Feb 10.

110. "Based on the more recent SCAT information (September 2011), remnant oil on barrier and mainland beaches ranges from no oil/lightly oiled to only a few moderately oiled sites noted in sections above." *See* DEIS 4-488; *see also* DEIS 4-503.

- This statement should be updated to reference more current SCAT information.

111. The DEIS states, "The DWH event and associated oil spill may have potentially impacted the terrapin community." *See* DEIS 4-760; *see also* DEIS 4-761; 4-762; 2-25; 2-56; 4-250, 4-251; 4-253; 4-254.

- This statement should include a note that, to date, there has been no evidence of spill-related impacts to terrapins.

112. The DEIS states, "The amount of impacted beach mouse habitat will be assessed in the summer of 2011." *See* DEIS 4-768.

- This statement should be updated with current information.

Water Quality/Water Column

Analysis:

113. The DEIS states, "Methane is a carbon source, such as oil, and its introduction into the marine environment could result in lowering dissolved oxygen levels due to microbial

degradation. For example, the DWH oil spill resulted in the emission of an estimated 9.14 x 109 to 1.25 x 1010 moles of methane from the wellhead (Kessler et al., 2011), with subsurface methane concentrations as high as~300μM (Joye et al., 2011)." *See* DEIS 4-24; *see also* DEIS 4-34.

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- Estimated methane concentrations from all relevant studies, not just the Kessler and Joye studies, should be used. For example, Valentine et al. (2010) used a higher gas-to-oil ratio to calculate a total methane emission of 1.29×10^{10} mol. Joye et al. detected a maximum methane concentration of 315 μM. By comparison, the maximum methane concentrations detected by Valentine et al.(2010) in June 2010 and Kessler et al. (2011) in August-October 2010 were 180 μM and 0.02 μM, respectively.
- Given methane's short half-life in the subsurface and the removal of methane through biodegradation by the fall of 2010, dissolved oxygen concentrations did not fall to anoxic levels as the result of methane releases. (*See, e.g.*, Valentine et al. 2010).
- Evidence from the DWH event indicates that methane gas from the well was rapidly broken down by bacterial action with little oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011).
- **References:**
  - Valentine et al., 2010, Propane respiration jump-starts microbial response to a deep sea spill. Science. 3: 208-311. October 8, 2010.
  - Kessler, J. D., et al., 2011, A Persistent Oxygen Anomaly Reveals the Fate of Spilled Methane in the Deep Gulf of Mexico, Science 331(6015):312–315.
  - Camilli, R., et al., 2010, Tracking Hydrocarbon Plume Transport and Biodegradation at Deepwater Horizon, Science 330:201-204.

114. The DEIS states, "In the case of the DWH event (consisting of a combination of oil and gas), it has been suggested that the addition of dispersants at the seafloor has resulted in large subsurface clouds of elevated methane concentrations." *See* DEIS 4-844.

- Turbulence is a primary cause of methane and oil dispersal from the wellhead and dissolution. The addition of dispersants may have contributed by decreasing oil droplet size, which would permit increased dissolution, but it did not "result in" the subsurface clouds and had no effect on methane concentrations in the subsea.
- **References:**
  - Atlas, R. M. and T. C. Hazen. 2011. Oil Biodegradation and Bioremediation: A Tale of the Two Worst Spills in U.S. History, Environ. Sci. Technol. 45(16):6709-6715.
  - Adams, E. E. and S. A. Socolofsky, 2004 (revised 2005), Review of Deep Oil Spill Modeling Activity Supported by the DeepSpill JIP and Offshore Operators Committee, DeepSpill JIP and Offshore Operators Committee.

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- Johansen, Ø. et al., 2000, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Cruise Report, SINTEF STF66 F00093.
- Johansen, Ø. et al., 2001, DeepSpill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000 Technical Report, SINTEF STF66 F01082.
- Johansen, Ø. et al., 2001, ROV sonar and visual pictures from the field trial "Deep Spill", June 2000, SINTEF.

115. The DEIS states, "Patin (1999) reported elevated concentrations of methane in the Sea of Asov resulting from gas blowouts from drilling platforms. He reported that these levels resulted insignificant species specific pathological changes. These include damages to cell membranes, organs and tissues, modifications of protein synthesis, and other anomalies typical for acute poisoning of fish. However, these impacts were observed at levels of 1-10 ml/L, which is higher than the background levels in the Gulf of Mexico." *See* DEIS 4-845.

- The Patin (1999) study discusses methane concentrations during Sea of Asov field observations as 4-6 ml/L near the well, and 0.07-1.4 ml/L at a distance 200 m from the platform (http://www.offshore-environment.com/gasimpact.html). The cited range of 1-10 ml/L is not based on these field studies but comes from a conceptual diagram describing the "approximate zone of acute toxicity based on a synthesis of studies." The description of the study should be revised to accurately reflect the Patin discussion.

116. The DEIS states, "Recently published research (Kessler et al., 2011) revealed that a large amount of methane was released by the DWH event and, based upon the methane and oxygen distributions measured at 207 stations in the affected area, a large amount of oxygen was respired by methanotrophs. Kessler et al.(2011) suggest that the methane triggered a large methanotroph bloom that rapidly degraded the methane, leaving behind a residual methanotrophic community." *See* DEIS 4-845.

- The following clarifying statement should be added. "Kessler et al. (2011) noted that methane concentrations by August 18 to September 2 were 'not exceeding ambient levels for the Gulf of Mexico.'"
- A statement should be added noting that typical methane concentrations observed by Kessler and Joye during the DWH spill were significantly lower than the levels in the Patin (1999) study, with the highest concentrations observed only in the subsea (>799m) near the wellhead. (Valentine et al. 2010).
- **References:**
    - Kessler, J. D., et al., 2011, A Persistent Oxygen Anomaly Reveals the Fate of Spilled Methane in the Deep Gulf of Mexico, Science 331(6015):312–315.
    - Valentine et al. 2010. Propane Respiration Jump-Starts Microbial Response to a Deep Oil Spill. Science. 330:208-211. October 8.

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117. The DEIS states, "In addition to oil, natural gas may also be explored for or produced in the GOM. Wells and sidetracks (smaller wells drilled as auxiliaries off main wells) may produce a mixture of both oil and natural gas. Condensate is a liquid hydrocarbon phase that generally occurs in association with natural gas. The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. Although there is not a 'typical' makeup of natural gas, it is primarily composed of methane (Maina, 2005). Thus, if natural gas were to leak into the environment, methane may be released to the environment. Methane is a carbon source, such as oil, and its introduction into the marine environment could result in lowering dissolved oxygen levels due to microbial degradation. For example, the DWH oil spill resulted in the emission of an estimated 9.14×10^{9} and 1.25×10^{10} moles of methane from the wellhead (Kessler et al., 2011), with subsurface methane concentrations as high as ~300 μM (Joye et al., 2011). This methane release corresponded to a measurable decrease in oxygen in the subsurface plume due to respiration by a community of methanotrophic bacteria. Unfortunately, little is known about the toxicity of natural gas and its components in the marine environment, but there is concern as to how methane in the water column might affect fish (**Chapter 4.2.1.18**)." *See* DEIS 4-456 to 4-457; *see also* DEIS 4-470.

- The discussion of methane release into the environment should reference data from Kessler et al. 2011, Ryerson 2011, and others indicating that, with respect to deep subsea releases, methane may be released into the water column but will not reach the surface, limiting environmental exposures to only the subsea compartment.
- This discussion should note that methane toxicity would be limited by the short half-life of methane in the subsea. (Kessler, 2011).
- The statement that "this methane release corresponded to a measurable decrease in oxygen in the subsurface plume due to respiration by a community of methanotrophic bacteria" should mention the OSAT finding that, while oxygen decline was measurable, it did not reach anoxic levels.
- **References:**
    - Kessler, J. D., et al., 2011, A Persistent Oxygen Anomaly Reveals the Fate of Spilled Methane in the Deep Gulf of Mexico, Science 331(6015):312–315.
    - Ryerson, T. B., et al., 2011, Atmospheric emissions from the Deepwater Horizon spill constrain air water partitioning, hydrocarbon fate, and leak rate, Geophysical Research Letters 38:L07803.
    - Ryerson, T. B., et al., 2012, Chemical data quantify *Deepwater Horizon* hydrocarbon flow rate and environmental distribution, PNAS, 10.1073/pnas.1110564109.
    - Yvon-Lewis, S. A., et al., 2011, Methane flux to the atmosphere from the Deepwater Horizon oil disaster, Geophysical Research Letters, 38 (L01602).

118. The DEIS states, "Most oil-spill-response strategies and equipment are based upon the simple principle that oil floats. However, as evident during the DWH event, this is not

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always true. Sometimes it floats and sometimes it suspends within the water column or sinks to the seafloor. Oil suspended in the water column and moving with the currents is difficult to track, and therefore recover, using standard visual survey methods (Coastal Response Research Center, 2007)." *See* DEIS 3-69.

- While oil may not rise to the surface and form a subsurface plume, formation of such a plume requires the presence of very specific conditions. Of relevance, any condition that produces very small dispersed oil droplets likely would result in oil being retained below the water's surface. One study found that oil would disperse subsea given narrow release apertures coupled with sufficiently energetic oil releases as could happen with high oil velocity levels.
- **References:**
  - Johansen SINTEF Report 2001, Deep Spill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – see pp. 124, 142 and 147.

119. The DEIS states, "Although unlikely in the WPA, vessel-generated waves and water-column turbulence have the potential to resuspend and transport remnant oil from the DWH event to the shoreline. Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Texas and Louisiana coasts." *See* DEIS 4-45.

- It should be clarified that "remnant oil" refers to tar mats or tarballs sunk near or at the shoreline, not oil in the water column or on the water surface. One study found that petroleum hydrocarbons had a degradation half-life of approximately one month, while the gas and n-alkanes had a half-life on the order of 2 days. This suggests that biodegradation likely rapidly depleted the subsurface dispersed oil once the release was stopped. With respect to oil on the surface, the last visible oil slick occurred on approximately August 3, 2010. (Reddy et al. 2011).
- Additionally, any remnant oil in shallow waters near the shoreline is being monitored closely for reoiling. (OSAT 2010).
- Based on SCAT oiling observations (January 21, 2012), the potential for resuspension of remnant oil from the DWH is likely low.
- Lastly, if any were to be resuspended, a large portion of the more toxic PAHs have been depleted as a result of oil weathering.
- **References:**
  - Boehm, P. D., et al., 2011, Aromatic Hydrocarbon Concentrations in Seawater: Deepwater Horizon Oil Spill, International Oil Spill Conference, May 23-26, Portland, Oregon, USA..
  - Boehm, P. D., et al., 2011, Distribution and Fate of PAH and Chemical Dispersants in the Water Column Following the Deepwater Horizon Oil Spill, SETAC North America 32nd Annual Meeting, November 13-17, Boston, Massachusetts, USA.

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  - Reddy et al., 2011, "Composition and fate of gas and oil released to the water column during the Deepwater Horizon oil spill," Proceedings of the National Academy of Sciences (PNAS), 10.1073/pnas.1101242108.

120. The DEIS states, "If any impacts do occur in the WPA, in spite of the remote distance from SWH, they will be a result of low-level or long-term exposure to dispersed, dissolved, or neutrally buoyant oil droplets." *See* DEIS 4-90.

- This discussion does not accurately convey the high rates of weathering and biodegredation that have already occurred on oil from the DWH event. This discussion should be revised to account for Boehm, and Gong, among others.
- This section should also reference Kessler, Valentine, Hazen and Camilli on the biodegredation of methane and other components.
- Water column monitoring data has not provided any evidence that oil remained in any appreciable concentrations at all. (*See* Operational Update with FOSC Rear Adm. Paul Zukunft, November 3, *available at* http://www.restorethegulf.gov/release/2010/11/03/transcript-operational-update-fosc-rear-adm-paul-zukunft)
- **References:**
  - Boehm, P.D., et al., 2011, Aromatic Hydrocarbon Concentrations in Seawater: Deepwater Horizon Oil Spill, International Oil Spill Conference, May 23-26, Portland, Oregon, USA.
  - Boehm, P.D., et al., Distribution and Fate of PAH and Chemical Dispersants in the Water Column Following the Deepwater Horizon Oil Spill, SETAC North America 32nd Annual Meeting, November 13-17, Boston, Massachusetts, USA.
  - Gong, C., et al. 2011. The Significant Impact of Weathering on MC252 Oil Chemistry and Its Fingerprinting Camples collected from May to September 2010. Poster Presentation at International Oil Spill Conference, May 23-26, Portland, Oregon.
  - Camilli, R., et al., 2010, Tracking Hydrocarbon Plume Transport and Biodegradation at Deepwater Horizon, Science 330:201-204.
  - Hazen, T. C., et al., 2010, Deep-Sea Oil Plume Enriches Indigenous Oil-Degrading Bacteria, Science 330:204-208.
  - Kessler, J.D., et al., 2011, A persistent oxygen anomaly reveals the fate of spilled methane in the deep Gulf of Mexico. Sciencexpress, January 6, 2011
  - Valentine et al., 2010, Propane respiration jump-starts microbial response to a deep sea spill. Science. 3: 208-311. October 8, 2010.

121. The DEIS states, "Recent data from studies of the DWH event and resulting spill showed that oil treated with dispersant at depth remained at a water depth between 1,100 and 1,300 m (3,609 and 4,265 ft) (Joint Analysis Group, 2010a). This subsea plume was in deep water rather than on the continental shelf. While the DWH event's

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subsea oil plume ranged through a 200-m (656-ft) depth range, it was thought to be bounded by stratified density layers of water." *See* DEIS 4-102.

- The Joint Analysis Group ("JAG") report cited, and JAG's Review of Preliminary Data to Examine Subsurface Oil, support that conclusion that small oil droplets and dissolved oil remained at a depth range of 1,000 to 1,300 or 1400 m (not 1,100 m). The first sentence should therefore be revised to correct this.
- This discussion should also note that these depth ranges are only approximations, since oil was not firmly bounded between these depths.
- This discussion suggests that oil was dispersed into the subsea solely because of the use of subsea dispersants. However, as noted elsewhere in the DEIS, oil was dispersed into the subsea as the result of physical dispersion (energy of the release) and not solely because of the use of subsea dispersants. *See* 4-123 ("However, it was injected into deep water under high pressure, which resulted in vigorous turbulence and the formation of micro-droplets that were not buoyant enough to float to the surface.").
- The sentence "[t]his subsea plume was in deep water rather than on the continental shelf" should be corrected due to the fact that this area still qualifies as part of the Outer Continental Shelf.

122. The DEIS states, "The Joint Analysis Group (2010a) reported that oil droplets less than 100 µm in diameter were likely to remain in the water column for several months." *See* DEIS 4-123.

- As noted above, this discussion does not include the concept of oil weathering, only that droplets of this size will not rise to the surface for months.

123. The DEIS states, "Water samples collected by the R/V *Weatherbird* on May 23-26, 2010, located 40 nmi (46 mi; 74 km) and 45 nmi (52 mi; 83 km) northeast and 142 nmi (163 mi; 263 km) southeast of the *Deepwater Horizon* rig revealed that concentrations of total petroleum hydrocarbons in the water column were less than 0.5 ppm (Haddad and Murawski, 2010)." *See* DEIS 4-124.

- This statement should provide more context by noting that concentration changes greatly over relatively short distances (as compared to the WPA), which is discussed in OSAT and Boehm.
- **References:**
  - Operational Science Advisory Team (OSAT), 2010, Summary report for sub-sea and sub-surface oil and dispersant detection: Sampling and monitoring, Unified Area Command, New Orleans, LA, Released on December 17, 2010.
  - Boehm, P. D., et al., 2011, Distribution and Fate of PAH and Chemical Dispersants in the Water Column Following the Deepwater Horizon Oil Spill, SETAC North America 32nd Annual Meeting, November 13-17, Boston, Massachusetts, USA.

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  - Boehm, P.D., et al., 2011, Aromatic Hydrocarbon Concentrations in Seawater: Deepwater Horizon Oil Spill, International Oil Spill Conference, May 23-26, Portland, Oregon, USA.
- This discussion should also consider OSAT-1, which examines a much larger data set than the limited, early sampling from the R/V *Weatherbird*.

124. The DEIS states, "Concentrations of dispersed and dissolved oil in the DWH subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010a; Lubchenco et al., 2010)." *See* DEIS 4-124.

- The timing of these findings should be specified, so as to indicate whether they were made during the spill.
- A more specific discussion of the rate at which concentration declines with increasing distance from the wellhead should be included.

125. The DEIS states, "Coastal water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts." *See* DEIS 4-452.

- This sentence should be revised in light of findings that coastal water quality was likely not affected by gas components, which dissolved completely at significant depths. (Kessler, et al., 2011; Valentine, et al., 2010; Ryerson, et al., 2011; Ryerson, et al., 2012).
- **References:**
  - Kessler, J. D., et al., 2011, A Persistent Oxygen Anomaly Reveals the Fate of Spilled Methane in the Deep Gulf of Mexico, Science 331(6015):312–315.
  - Valentine et al., 2010, Propane respiration jump-starts microbial response to a deep sea spill. Science. 3: 208-311. October 8, 2010.
  - Ryerson, T. B., et al., 2011, Atmospheric emissions from the Deepwater Horizon spill constrain air water partitioning, hydrocarbon fate, and leak rate, Geophysical Research Letters 38:L07803.
  - Ryerson, T. B., et al., 2012, Chemical data quantify *Deepwater Horizon* hydrocarbon flow rate and environmental distribution, PNAS, 10.1073/pnas.1110564109.

126. The DEIS states, "It is currently impossible to estimate precisely the long-term impacts that the spill from the DWH event will have on coastal water quality. Various monitoring efforts and environmental studies are underway. More time is needed to fully assess the impacts of the DWH event. Although response efforts decreased the fraction of oil remaining in Gulf waters and reduced the amount of oil contacting the coastline, oil still remains in the environment (SCAT, 2011a and 2011b; OSAT-2, 2011). As such, there remains some incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on coastal water quality. Much of this

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information relates to the DWH event and is continuing to be collected and developed through the NRDA process. These data collection and research projects maybe years from completion. Few data or conclusions have been released to the public to date. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline of this EIS. In light of this incomplete and unavailable information, BOEM subject matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data on sediments and water quality that have been released, as described above, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives." *See* DEIS 4-454; *see also* DEIS 4-466.

- The first sentence presumes that the spill will, in fact, have long-term impacts on coastal water quality, which is unproven. This sentence should be removed or revised.
- The statement that "few data or conclusions have been released to the public to date[]" should be revised in light of the fact extensive data has been released and more data will be released in the future as NRDA efforts continue. In particular, OSAT-2 states that "[i]n most locations, models predict PAH concentrations in supratidal buried oil will decrease to 20% of current levels within 5 years. However, there are isolated conditions where PAH concentrations are predicted to persist substantially longer." There have also been some initial studies of marsh impacts in 2010 and 2011. (Mishra, et al. 2012; Steyer, et al., 2011; Khanna, et al., 2011).
- **References:**
  - Khanna, S., et al., Detection of salt marsh vegetation stress after the DWH BP oil spill along the shoreline of Gulf of Mexico using AVIRIS hyperspectral data, AGU Fall Meeting 2011, December 5-9, San Francisco, California, USA.
  - Mishra, D.R., et al., Post-spill state of the marsh: Remote estimation of the ecological impact of the Gulf of Mexico oil spill on Louisiana Salt Marshes, Remote Sensing of Environment, 118:176-85, 2011.
  - Steyer, G., et al., Wetland vegetation monitoring within Barataria Basin, Louisiana following exposure to oil, AGU Fall Meeting 2011, December 5-9, San Francisco, California, USA.

127. The DEIS states, "There were 63 water samples out of 3,605 collected from deep water (>200 m; 656 ft) that exceeded the USEPA aquatic life benchmarks for PAH (OSAT, 2010). Exceedances occurred near the water surface or in the southwest traveling deepwater plume within 70 km (43 mi) of the well." *See* DEIS 4-563.

- 3,612 water samples were collected. Out of these 3,612 samples, 70 samples exceed the benchmark. Of those 70, 63 were associated with MC252 oil. Thus, the sentence should be revised to read, "There were 63 water samples out of 3,612

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collected from deep water (>200 m; 656 ft) that exceeded the USEPA aquatic life benchmarks for PAH and were associated with MC252 oil (OSAT, 2010)."

128. The DEIS states, "Evidence shows that gas and oil from the DWH event in the water column has rapidly deteriorated (Hazen et al., 2010)." *See* DEIS 4-182.

- Instead of "deteriorated," this statement should say "biodegraded."

Seagrasses

Analysis:

129. The DEIS states, "The seagrasses behind the Chandeleur Island chain and SAV communities within Plaquemines and St. Bernard Parishes had contact with the oil from the DWH event and had considerable physical stress from various prevention and cleanup efforts (USDOC, NOAA, 2010n). It is assumed that there will be a decrease in submerged vegetation and a negative impact on the communities in the areas affected by the DWH event. . . .

Mississippi Sound had oil slicks from the DWH event, and some beds within that area had contact with both tarballs and oil (USDOC, NOAA, 2010q). With accrued oil in the area of Mississippi Sound, there is the potential for at least short-term decreases in seagrass cover and an adverse effect on the associated community. . . .

In the past 5 years, Florida had six tropical cyclones made landfall on its western coast. These were Tropical Storm Alberto and Hurricane Ernesto in 2006, Tropical Storms Barry and Olga in 2007, Tropical Storm Fay in2008, and Tropical Storm Claudette in 2009 (USDOC, NOAA, 2010c). These storms impacted different parts of the Florida coast from the panhandle to Tampa and the Keys. The panhandle was exposed to oil and tarballs from the DWH event, but the majority of the seagrass beds in south Florida received little impact from the DWH event (USDOC, NOAA, 2010n)." *See* DEIS 4-521, 4-522, 4-523.

- The first sentence should be revised to note that seagrasses behind the Chandeleur Island chain only "likely" had contact with oil.
- The source cited does not indicate that the area west of the Chandeleur Island chain "had considerable stress from various prevention or cleanup efforts" or that SAV was directly affected by oil from the DWH event. This discussion should be revised to cite a source which discussed cleanup efforts in this area.
- The sentence asserting that "it is assumed there will be a decrease in submerged vegetation and a negative impact" should cite to a source that specifies who is making the assumption, what specific types of communities will likely be affected, and how long effects are expected to last.
- The source cited does not mention the Mississippi Sound. Thus, this discussion should include consideration of USDOC, NOAA, 2010n (ERMA), which indicates that the cumulative oiling footprint did reach the Mississippi Sound and

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that SCAT surveys detected mostly light to heavy oiling on the barrier islands, with mostly no observed oil to light oiling (with a few moderate to heavy oiling locations) on the main coast of the Mississippi Sound.

- The sentence beginning "with accrued oil . . ." should be revised to read: "there is the potential for oil contact with SAV and short-term decreases . . ."
- Based on the source cited, there was no oiling observed in seagrass beds located in South Florida. This statement should be revised to indicate that there was no evidence of impact. The 2010 NRDA assessment plan to study turtles in *Sargassum* communities originally included Florida locations south of the panhandle, but by 2011, excluded them because "they were considered unlikely to contain exposed *Sargassum* and turtles." (Industrial Economics, Inc., 2011 Addendum to the Assessment Plan for Juvenile Sea Turtles in Sargassum Communities, dated May 13, 2011).

Sargassum

Analysis:

130. The DEIS states, "the highest concentration of *Sargassum* in the GOM during the months of June and July was in the vicinity of the DWH event in the CPA. *Sargassum* populations in the CPA at the time would have been affected, while populations in the WPA were unaffected. Surface oil from the DWH event commonly coincided with lines and mats of *Sargassum*, and *Sargassum* mats were found immersed in oil with little or no visible living-associated organisms (Witherington, official communication, 2011). Dead *Sargassum* would have sunk to the seafloor, possibly affecting localized areas of benthic habitat. If a noticeable decline in GOM *Sargassum* biomass occurs as a result of the DWH event, it may also adversely affect the biomass of *Sargassum* in Atlantic waters because of the annual movement of *Sargassum* from the GOM into the Atlantic (Gower and King, 2008). Once water quality in the GOM returns to pre-DWH event conditions, *Sargassum* and its associated communities can return to previous levels of abundance and species composition." *See* DEIS 4-113.

- The first two sentences appear to rely on unverified personal communications and incorrectly suggest that *Sargassum* was concentrated near the wellhead. Either a source should be cited or the first sentence revised to read: "The highest concentrations of *Sargassum* in the GOM during the months of June and July are typically observed in areas where there was at least some surface oiling during a portion of the DWH release."
- The discussion of Witherington should clarify that, though *Sargassum* mats were found immersed in oil, these findings were intermittent and of short duration, potentially ending by July 2010 (*see, e.g.*, http://www.nytimes.com/2010/09/14/science/earth/14spill.html?pagewanted=all).
- The assertion that "dead *Sargassum* would have sunk to the seafloor, possibly affecting the localized areas of benthic habitat" is hypothetical and not supported

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by any source. This statement should be rephrased to read, "If dead *Sargassum* sunk to the seafloor, it may have affected . . ."

American Petroleum Institute

API-1 Comment noted. If the ASLM's decision is to hold a lease sale under either Alternative A or Alternative B, it will be announced in the Final Notice of Sale.

API-2 We are aware of plans to potentially expand the boundaries of the Flower Garden Banks National Marine Sanctuary. No decisions have been made at this point in time regarding exclusion of any new sanctuary areas from future lease sales. This Multisale EIS is not the appropriate vehicle for BOEM to state a position on what policy will be implemented in any new areas added to the sanctuary.

API-3 All recently published technical reports that you have cited have been reviewed by our subject-matter experts and incorporated into the Final Multisale EIS as appropriate.

API-4 We recognize the large size of the EIS and the redundancy among sections. An outline similar to the one you propose was used in past documents. This outline was replaced with the current one, in part because the former outline required the reader to move back and forth in the document in order to follow a given resource through the various sections describing the affected environment and the impacts to that resource. In addition, while some resources have similar discussions for both the WPA and CPA, other resources are very different in the two planning areas, including several resources that only occur in the CPA.

API-5 This EIS provides detailed descriptions of the administrative and regulatory changes made by BOEMRE following the DWH event and oil spill (**Chapter 1.3.1**), which are in effect to minimize the risk of future blowouts and oil spills. This chapter describes the regulatory framework already in place, requiring that the OCS leasing process and all activities and operations on the OCS comply with other Federal, State, and local laws and regulations. Since these documents are generally applicable and readily available from BOEM or on the Internet, detailed descriptions are unnecessary and duplicative in this Multisale EIS. All NTL's are updated and fully described on BOEM's website. Where relevant to the NEPA analysis, BOEM has included information on containment capabilities, including but not limited to, the Marine Well Containment Company and Helix Energy Solutions Group.

API-6 Language has been added to the **Summary and Chapter 2**, where appropriate, to clarify that the "Catastrophic Spill Event Analysis" is found in **Appendix B**.

API-7 See pages 4-5 through 4-9 and 4-436 through 4-438 of the Draft Multisale EIS. Where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives and, if so, was either acquired or, in the event it was impossible or exorbitant to acquire the information, accepted scientific methodologies were applied in its place. In addition, individual resource analyses highlight where information was incomplete or unavailable.

API Enclosure 1

API 1-1 Comment noted.

API 1-2 **Abbreviations and Acronyms** were provided on pages xliii-xlvii of the Draft Multisale EIS.

API 1-3 Climate change is a global phenomenon influenced by many activities worldwide. The BOEM's policy is to address programmatic issues such as global warming at the Five-Year Program level rather than at the individual lease sale level. See **Appendix G.3** for a discussion of the impacts of climate change.

API 1-4 Mason (2010) is cited in **Chapters 4.1.1.20.3 and 4.2.1.23.3** of the Draft Multisale EIS. A statement that incorporates Mason (2009) was added in the Final Multisale EIS under the "Description of the Affected Environment."

API 1-5 In lengthy documents such as this Multisale EIS, BOEM's established practice is to group the numerous tables in a separate location in the document rather than embedding them in the text. Due to widely varying table lengths and formats, it is not practical to embed them in the text.

API 1-6 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-7 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-8 The BOEM has updated the Final Multisale EIS to indicate that the annual OCS emissions in **Table 4-2** are based on the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010). Text on the GOADS methodology has been added to the Final Multisale EIS for clarification. Potential air quality impacts from a WPA proposed action are shown in **Table 4-2**; furthermore, when an operator submits an EP, DOCD, or DPP for postlease activities, site-specific information is provided. The site-specific information is used to determine whether their planned activities reach thresholds requiring additional data submissions and air modeling. Clarifying language has been provided in the Final Multisale EIS. The BOEM subject-matter experts have included the information and data deemed most relevant to the decisionmaker and public in evaluating impacts of the proposed actions and alternatives. Conforming language was added to **Chapter 4.1.1.1.2**, which also refers the reader to the postlease plans review process for air quality reviews in **Chapter 1.5**.

API 1-9 The global CO_2 emissions in 2010 are estimated to be about 33.0 billion tons/year (Olivier et al., 2011); the annual CO_2 emissions in the WPA and CPA are estimated at 0.34 and 1.3 million tons, respectively. The CO_2 emissions attributable to the WPA and CPA are estimated to be about 0.005 percent of total global CO_2 emissions annually. Therefore, CO_2 emissions from the WPA and CPA would not contribute significantly to climate change.

Conforming language to indicate BOEM's interaction with USEPA's Greenhouse Gas Reporting Rule has been added to the document. The BOEM subject-matter experts have included the information they deem relevant and useful to the decisionmaker and public in its evaluation of the proposed actions and alternatives, including relevant information on USEPA's Greenhouse Gas Reporting Rule. Additionally, climate change is addressed in the Five-Year Program EIS issued by BOEM's Headquarters Office because the subject matter is not unique to the GOM program.

API 1-10 Comment noted. Where possible, the text of the Final Multisale EIS was revised to eliminate redundancy. The BOEM feels it would be impractical to perform a major restructuring of the presentation of the socioeconomic sections, making it more difficult for the decisionmaker and the public to find updates on materials and issues considered in the Draft Multisale EIS. In addition, there are some benefits of redundancy, particularly to readers who are less familiar with some definitions that we use in our socioeconomic analyses.

API 1-11 The summaries have been revised to make the format consistent.

API 1-12 Comment noted. These summaries are only meant as a brief capsule of the conclusions presented in **Chapter 4**. The reader is directed to the respective resource sections in **Chapters 4.1 and 4.2**.

API 1-13 We recognize the large size of this Multisale EIS and the redundancy among sections. An outline similar to the one you propose was used in past documents. This outline was replaced with the current one, in part because the former outline required the reader to move back and forth in the document in order to follow a given resource through the various sections describing the affected environment and the impacts to that resource. In addition, while some resources have similar discussions for both the WPA and CPA, other resources are very different in the two planning areas, including several resources that only occur in the CPA.

API-14 On May 13, 2010, USEPA issued a final rule that establishes thresholds for greenhouse gas emissions that define when permits under the New Source Review Prevention of Significant Deterioration (PSD) and Title V Operating Permit programs are required for new and existing industrial facilities (the "Greenhouse Gas Reporting Rule"). This final rule tailors the requirements of the CAA permitting programs to classify which facilities will be required to obtain PSD and Title V permits.

Once the Greenhouse Gas Reporting Rule is fully implemented, a source of greenhouse gases would be considered major for purposes of the PSD and Title V permit programs during the first phase of implementation of the rule (to last for 6 years) if it has a potential to emit in excess of 25,000 tons of regulated greenhouse gases (on a "carbon dioxide equivalent" basis). The significance level for modifications of major sources triggering permit requirements would be established between 10,000 and 25,000 tons of regulated greenhouse gases during Phase I. The amount of CO_2 emissions from a typical well site on average is about 237-439 tons per year. Therefore, individual wells would not be expected to trigger reporting under the Greenhouse Gas Reporting Rule.

Chapters 4.1.1.1.4 and 4.2.1.1.4, include the annual CO_2 emissions nationally and globally, and the relative percentage attributable to OCS activities.

API-15 An accidental event could result in offshore air degradation, resulting in human and wildlife inhalation exposure to H_2S, hazardous air pollutants (HAP's), oil and gas combustion products, methane, and exposure to hazardous chemical products stored on the rig or platform e.g., hydrofluoric acid. The BOEM's subject-matter experts have included the information and data deemed most relevant to the decisionmaker and public in evaluating impacts of the proposed actions and alternatives. Available onshore monitoring data indicate that air quality is not being significantly impacted by offshore sources. In addition, even during the height of the DWH spill and response, USEPA data indicate that onshore air quality was not significantly impacted. As such, BOEM believes the Final Multisale EIS remains accurate in its description of potential impacts from an accidental event.

Depending on the location of a future accidental event, it is expected that HAP emissions resulting from an accidental event would have only a minimal effect on onshore air quality. Additionally, responders to an offshore accidental event could be exposed to HAP's. At the postlease stage, when additional site-specific information is available that makes modeling feasible, industry is required to submit information on H_2S potential and, if it exceeds a certain level, the lessee is required to perform modeling. The USCG and OSHA also regulate worker safety and exposures.

API-16 Clarifying language has been added to **Chapters 4.1.1.1.4 and 4.2.1.1.4**.

The amount of CO_2 emissions from a typical well site on average is about 237-439 tons per year.

API-17 The BOEM concurs. Clarifying language has been added as footnotes to **Tables 4-2 and 4-64** to better explain that they apply to annualized emissions from all proposed lease sales.

API 1-18 Comment noted. The text of the Final Multisale EIS has been revised to incorporate the forecasted demand for oil and gas.

API 1-19 There are many such laws and regulations listed, e.g., the Endangered Species Act and the Clean Water Act, but a more complete description of the listed laws and regulations is provided in Matthews and Cameron (2010) as noted.

API 1-20 See the response to comment API 1-19.

API 1-21 Comment noted.

API 1-22 Comment noted. There was only one meeting per state; therefore, the listing of each state in which a meeting was held was deemed adequate.

API 1-23 Comment noted. This section describes many postlease activities and BOEM regulations or other laws or regulations that may have a bearing on such activities. It was not meant to be an inclusive list of all such regulations.

API 1-24 Comment noted.

API 1-25 The data are from the U.S. only. Worldwide data could be misleading in this context because regulations vary by country and differ in many aspects from U.S. regulations.

API 1-26 The figure has been revised accordingly.

API 1-27 Comment noted. The sections have been revised to eliminate the mention of features outside of the planning area being discussed, except where appropriate (e.g., CPA activities can have impacts in Texas).

API 1-28 Comment noted. The BOEM subject-matter experts included the available data from USEPA that was sampled during the DWH event, as summarized in **Chapter 4.1.1.1.3**. In addition, a catastrophic events analysis, including potential air impacts, is discussed in **Appendix B**.

API 1-29 The comment has been considered. However, BOEM's subject-matter expert considered the reference to the impacts of a catastrophic event in the full **Chapter 4** discussions and in **Appendix B** to be sufficient.

API 1- 30 There are more details about cumulative effects in **Chapter 4.1.3.4**. This is a summary; therefore, it does not warrant the peer review information like the detailed information provided in **Chapters 4.1.1.3.3 and 4.1.1.3.4**.

API 1- 31 This is a summary; therefore, if more details are of interest, please see **Chapters 4.1.1.4.3 and 4.1.1.4.4**. Also, this is the WPA and there were not extensive impacts to wetlands from the DWH event.

API 1-32 Comment noted. The text in **Chapter 2** is only meant as a summary; this NTL is discussed in **Chapters 4.1.1.8, 4.1.1.9, 4.2.1.9, and 4.2.1.10.**

API 1-33 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-34 For the purposes of this EIS, "significant" refers to population-level impacts. Under the CEQ regulation, significance is viewed in terms of both context and intensity. Significance includes spatial and temporal scale, as well as the severity of impacts. Throughout the coastal and marine birds' sections, BOEM is anticipating and predicting levels of impacts to avian resources in both the CPA and WPA, but for the most part, these impacts are not expected to rise to the population level.

With regard to API's comment on individual species baseline data, it is virtually impossible to derive estimates for the more than 200 species of birds collectively considered herein. Even if the information was available, BOEM believes that the level of detail required would hinder rather than assist the decisionmaker and public in evaluating the proposed actions and alternatives in any meaningful way. In addition, one would have to separate breeding populations from wintering populations and, for some species, there is mixing in the Gulf of Mexico during the fall staging and the wintering period. For some species, reasonably accurate population estimates are simply unavailable and, in many cases for species in which population estimates are available, it would be difficult to assign relative proportion of the continental population comprised of birds either breeding or wintering in the Gulf of Mexico.

Finally, the erroneous reference to "sea turtle" in the identified paragraph has been corrected.

API 1-35 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-36 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-37 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-38 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-39 Comment noted. The text of the Final Multisale EIS has been corrected to refer to the CPA.

API 1- 40 There is no inconsistency regarding the discussion of the EPA's lease activities. The text indicates that the EPA proposed actions, lease sales, and all potential associated impacts will be addressed in a separate EIS, and this is the case. **Chapter 3.1.1.1.2 and Table 3-4** represent information on the entire Gulf of Mexico OCS Program, which includes the EPA. The EPA should not be considered under **Chapter 3.1.1.1.1**, "Proposed Actions," which discusses the proposed actions and lease sales in the WPA and CPA, but the EPA should be mentioned in the next chapter, which is **Chapter 3.1.1.1.2**, "OCS Program." If the EPA was left out of this chapter, it would not be a complete disclosure of all Gulf of Mexico OCS Program activities.

The data in **Table 3-4** does include EPA future forecasts. All cumulative case forecasts include all previous and future leasing activities. This is a total Gulf of Mexico OCS Program activity table; therefore, it would include all previous and future activities within all areas of the GOM. The data in the cumulative WPA and CPA OCS Program tables, i.e., **Tables 3-5 and 3-6**, appear to add up to the values found within **Table 3-4**, which is the table for the total OCS Program, because in most cases, the WPA and CPA leasing activities are the only activity. This is due to the fact that there are no EPA lease activities in those instances. The EPA cumulative activities only represent ~1 percent of the total Gulf of Mexico OCS Program activities and are barely discernable within a total Gulf of Mexico OCS Program activities cumulative analysis.

API 1-41 Clarifying language has been provided in **Chapter 3.1.1.5**.

API 1-42 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-43 Comment noted. The **Abbreviations and Acronyms** section of the Final Multisale EIS has been corrected.

API 1-44 The modeling in this section focused on the fates of the estimated *median* size spill ≥1,000 bbl and not on a catastrophic spill event. However, we have included a DWH event example in **Chapter 3.2.1.5.4** under "Persistence."

API 1-45 The reference has been updated to reflect the McNutt et al. (2011) report.

API 1-46 The status of Alabama and Mississippi activity has been updated.

API 1-47 Comment noted.

API 1-48 The text of the Final Multisale EIS has been edited to correct the inconsistency.

API 1-49 Comment noted. **Table 3-30** provides geographic information with latitude and longitude for Mississippi and Alabama as well as for the other states discussed.

API 1-50 The status of the Gulf Gateway has been updated.

API 1-51 The reference to Golden Pass has been deleted from the text.

API 1-52 The first sentence of the paragraph states that "shale gas" is a new source of onshore natural gas. The purpose of the paragraph is to discuss the impact that this new source of onshore gas will potentially have on all LNG facilities (onshore and offshore).

API 1-53 The text of the Final Multisale EIS has been revised to update some of the information.

API 1-54 The text of the Final Multisale EIS has been revised to update the information.

API 1-55 Comment noted.

API 1-56 The text of the Final Multisale EIS has been revised to include mention of the draft Louisiana Coastal Master Plan and a link to the document. The comment period closed on February 25, 2012. When the Master Plan is finalized, the information will be included in future documents.

API 1-57 Comment noted.

API 1-58 The text "and pipeline access canals" has been removed from the Final Multisale EIS.

API 1-59 This language has been clarified in the Final Multisale EIS.

API 1-60 This language has been added in **Chapters 4.1.1.1.2 and 4.2.1.1.2**, which address potential impacts.

API 1-61 The typographical error has been corrected and clarifying language has been added to **Chapter 4.1.1.1.1** of the Final Multisale EIS.

API 1-62 This language has been clarified in the Final Multisale EIS.

API 1-63 This language has been clarified in **Chapters 4.1.1.1 and 4.2.1.1** of the Final Multisale EIS.

API 1-64 This language has been clarified in the Final Multisale EIS.

API 1-65 This language has been clarified in the Final Multisale EIS.

API 1-66 This language has been clarified in the Final Multisale EIS.

API 1-67 Comment noted. The correction to "and" has been made in the Final Multisale EIS.

API 1-68 The statement has been removed from the Final Multisale EIS in both WPA and CPA. These regulations are generally from USEPA, not the State.

API 1-69 Climate change is discussed on a programmatic level in the Five-Year Program EIS and not in detail within this Multisale EIS. Impacts from nutrient input from various factors, which could result from coastal development as well as natural events, are discussed in the first full paragraph on page 4-80 and in the same area in the CPA on page 4-528. It is not necessary to specifically state coastal development.

API 1-70 The addition of an appendix containing the NTL and map package was discussed internally, and it was determined that it will not be added to the Multisale EIS. The information is available on the BOEM website.

API 1-71 The typographical error has been corrected in the Final Multisale EIS.

API 1-72 This level of detail was taken into consideration by the subject-matter expert, and it was determined that it was not useful for the decisionmaker or the public in evaluating the proposed actions and alternatives. Thus, BOEM believes that the information provided on noise levels remains accurate.

API 1-73 See the response to comment API 1-72.

API 1-74 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-75 Although the comment refers to whether impacts to seagrasses may indirectly affect sea turtles (presumably via impacts on hatchling habitats), BOEM believes the comment relates more to *Sargassum*. As *Sargassum* serves as hatchling habitat for sea turtles rather than seagrasses, the text of the Final Multisale EIS has been revised to address the comment regarding *Sargassum*.

API 1-76 Both **Chapters 4.1.1.11.4 and 4.1.1.12.4** make the following statement that a decision can be made with the recognition that there is incomplete or unavailable information: "Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this EIS (including the No Action and Action alternatives) for the three main reasons" identified in those sections.

API 1-77 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-78 The BOEM regulations require that when modeling is mandated, it follow USEPA guidelines published in Appendix W of 40 CFR 51. The Offshore Coastal Dispersion Model (OCD) has been the approved model for offshore emissions. Although dated, the model is appropriate for prelease onshore impacts estimates because it provides conservative results. For example, the 2007-2012 Multisale EIS's (USDOI, MMS, 2007c) OCD modeling results were presented for the WPA in Tables 4-18 and 4-19 and for the CPA in Tables 4-26 and 4-27. These tables are incorporated by reference. The BOEM believes that these incorporated tables remain adequate because of the similarities between the 2007-2012 and the 2012-2017 scenarios, including that a number of impact-producing scenarios were actually estimated to be higher in the 2007-2012 Multisale EIS. The increase in the number of exploration and delineation wells in the 2012-2017 scenario, however, occurs in all water depths, so increased emissions would be throughout the WPA rather than concentrated in blocks nearer to shore. These tables do not include the 1-hour NO_x and SO_x modeling results. The BOEM has relied on 1-hour NO_x OCD modeling performed by operators during the postlease plans approval process to validate that projected emissions do not exceed the 1-hour NO_x standard. The SO_x exceedances of the hourly and annual exemption levels are less frequent. The BOEM has not required SO_x modeling since the 1-hour SO_x standard went into effect.

However, for postlease applications, BOEM considers requests to use other models approved for use in USEPA's Appendix W.

API 1-79 This was a general statement about the resiliency of this species based on the research. The statement "such as DWH" has been removed.

API 1-80 The data presented are from a 3-day cruise that occurred a short time after the spill. Only 25 samples were collected in total. Samples were collected at three stations at 6-12 discrete depths at each of the three stations. Only one sample was collected at discrete depths at each station. Total petroleum hydrocarbon concentrations were less than 0.5 mg/L (ppm) at all stations and depths (Haddad and Murawski, 2010).

API 1-81 Comment noted. The text has been revised to address the comment.

API 1-82 See the response to comment API 1-72.

API 1-83 See the response to comment API 1-72.

API 1-84 The BOEM believes that the statement in the Final Multisale EIS remains accurate: "In April 2011, NMFS received a revised complete application from BOEM requesting an authorization for the take of marine mammals incidental to seismic surveys on the OCS in the Gulf of Mexico (76 FR 34657). The NMFS has not finalized the EIS at this time."

As both formal and informal consultations with NMFS remain ongoing and the Biological Assessment is in development, it would be inappropriate to provide a potential number on "takes" that could result from the proposed actions. The consultation process remains ongoing and is the appropriate forum for this evaluation.

API 1-85 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-86 The section was rearranged and edited between the Draft and Final Multisale EIS's to make it more cohesive and easier to understand by the decisionmaker and public, and potentially conflicting statements were removed or clarified.

API 1-87 Citations were added as appropriate.

API 1-88 Comment noted. The BOEM subject-matter expert has included the information deemed relevant, including the DWH event, drilling suspensions, hurricanes, and recessions where appropriate.

API 1-89 Comment noted. The "geo-racial composition of the OCS workforce" cannot be determined/separated out from the general population data, and racial composition of the OCS workforce is not reported by the industry. As any individual lease sale or group of lease sales would not be expected to have more than a negligible impact, if any, on racial or ethnic composition, the text has been edited for clarification.

API 1-90 Comment noted. The text of the Final MultisaleEIS has been revised to address the comment.

API 1-91 Comment noted. The text has been of the Final Multisale EIS has been revised for clarification.

API 1-92 Comment noted. The BOEM subject-matter expert made the decision to leave the discussion of the percentage of the economy that is impacted by OCS activities in the "Routine Events" and "Cumulative Impacts" sections. These sections contain detailed data on the percent of certain areas that are impacted by OCS activities.

API 1-93 The BOEM added statements in the No Action Alternative sections for the CPA and WPA; these statements elaborate on the economic impacts of cancelling a proposed lease sale.

API 1-94 Comment noted. **Table 4-51** has been revised to address the comment.

API 1-95 Comment noted. The BOEM subject-matter experts included the information that they felt was relevant to the decisionmaker and public in evaluating the proposed actions and alternatives. The new regulatory requirements are described in **Chapter 1.3.1**. Therefore, a sentence was added in **Chapters 4.1.1.20.3.1 and 4.2.1.23.3.1** that refer to **Chapter 1.3.1** for more information on these new requirements.

API 1-96 Comment noted. An additional sentence was added that elaborates on the role of IMPLAN in determining the multiplier effects of the OCS Program. The distinction between jobs being created or being saved is discussed at the end of the "Proposed Action Analysis" section.

API 1-97 The MAG-PLAN does not incorporate these issues into its structure. Therefore, a sentence was added in the "Background/Introduction" section that discusses some of the limitations of MAG-PLAN.

API 1-98 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-99 The BOEM added statements in the No Action Alternative sections for the CPA and WPA that elaborate on the economic impacts of cancelling a proposed lease sale.

API 1-100 There is an important distinction between the information in the "Routine Events" section (page 4-945) and the information in the "Cumulative Impacts" section (pages 4-947 and 4-948). Namely, the "Routine Events" section presents MAG-PLAN output for a proposed action, while the "Cumulative Impacts" section presents MAG-PLAN output for the entire OCS Program.

API 1-101 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

A phrase that refers to **Chapter 3.1** was added for more information on the cumulative scenario.

API 1-102 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-103 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-104 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 1-105 Comment noted. The BOEM subject-matter expert has included the information deemed relevant. The EIS includes the topics of greatest relevance to the decisionmaker and the public in evaluating a proposed action and its alternatives. Therefore, BOEM believes it is valuable to have some context for consideration of environmental justice issues provided within the same section, rather than requiring the decisionmaker and public to jump back and forth between sections.

API 1-106 Comment noted. There is no mention of IMPLAN in the EIS in **Chapters 4.1.1 20.4 and 4.2.1.23.4**. IMPLAN is discussed elsewhere in the Final Multisale EIS. The geographical size of BOEM-identified economic impact areas (EIA's) resulted in IMPLAN outputs that are not useful for an analysis of environmental justice concerns precisely because of their regional nature. Therefore, BOEM does not use IMPLAN for the environmental justice analysis. The BOEM subject-matter experts have determined that there are limitations in applying either the IMPLAN or MAG-PLAN models to environmental justice (as opposed to considerations of geographic proximity), and thus, in **Chapters 4.1.1.20.4 and 4.2.1.23.4**, BOEM has used other methods and data to evaluate potential environmental justice concerns and impacts. For purposes of this EIS, BOEM conservatively assumes that there may be localized environmental justice concerns in areas with ties to OCS oil and gas development activities (e.g., Port Fourchon).

API 1-107 Comment noted. To claim that a single proposed action will "fully utilize related support systems" would be misleading. Much more is involved in the utilization of related support systems than the few impacts of one lease sale or a group of lease sales. Therefore, the text was revised for clarification.

API 1-108 Comment noted. The discussion of accidental events in this location appropriately follows the outline of the entire Final Multisale EIS. It addresses those events that may occur accidentally and how they might affect lower-income and minority populations. The BOEM subject-matter experts felt the section remained accurate.

API 1-109 The sentence immediately preceding the referenced sentence states that these would be "Federal/State/regional/local regulatory mechanisms." The text in the Final Multisale EIS was revised to add examples for clarity.

API 1-110 The tables have been corrected.

API 1-111 The table has been corrected.

API 1-112 The BOEM believes that **Table 4-2** is accurate as currently presented and believes that segmenting the emissions would be more confusing rather than aggregating data for all OCS activities to prevent the risk of underreporting.

API 1-113 **Appendix B** addresses a hypothetical, low-probability, catastrophic spill. All actual spills differ in their impacts based on many factors. Therefore, the discussion is qualitative rather than quantitative, and it centers on general categories of impacts rather than specific details, which would be unknown for any actual future spills.

API Enclosure 2

API 2-1 Where appropriate, the word "results" was changed to the word "analyses."

API 2-2 Your comment has been incorporated in the section where the subject-matter experts felt it was most pertinent (e.g., **Chapter 3.3.5.1**, "Physical Oceanography"). In this section, improved reference to the sampling data that you mention has been made. The addition of references for the statement in other circumstances is not necessary, as it is referencing the model or the specific idea discussed in the Adcroft paper. Where relevant, the text of the Final Multisale EIS has been revised.

API 2-3 We clarified our statement accordingly, where appropriate, but with some modification to fit the reference being made to both fluorescence and oxygen measurements. The reference to fluorescence as used in **Chapter 3.2.1.9.2** is appropriate, and no changes to the text in this section were deemed necessary.

API 2-4 Comment noted. The specifically referenced text is not in the "Environmental Justice" sections. However, it has been considered, but it does not necessitate alteration of the "Environmental Justice" sections other than referring the reader to the "Air Quality" section where it is discussed.

API 2-5 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-6 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-7 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-8 Comment noted. The text in **Appendix B** of the Final Multisale EIS has been revised to address the comment.

API 2-9 Comment noted. The text in **Appendix B** of the Final Multisale EIS has been revised to address the comment.

API 2-10 This statement is based on available reports of known impacts, but the subject-matter expert felt that this level of detail, over and above the statements provided in **Chapter 4**, was not useful to the decisionmaker or public in evaluating a proposed action and alternatives. Nevertheless, according to a recent report, SCAT archaeologists identified 77 archaeological sites (both historic and prehistoric) in the 5,000 km (3,107 mi) of coastline they surveyed that "exhibited signs of oiling" (HDR, 2011, page iii). While no further investigations have been conducted to assess the effects of the oiling on prehistoric sites, a parallel may be drawn between prehistoric sites along the Gulf Coast and those that experienced oiling as a result of the *Exxon Valdez* spill in Alaska. A 1990 study administered by the U.S. Dept. of Agriculture, Forest Service (Mifflin and Associates, 1991) concluded that significant effect to radiocarbon dating processes occurred, which could be partially reduced by cleaning the sample. A 1991 study conducted by the State University of New York concluded that the presence of oil residue in site sediments resulted in the need for increased radiocarbon processing and thus higher research costs in the spill area (Bittner, 1996, page 816). Bittner (1996, page 816) also reported in the Alaska case that the most extensive damage to archaeological sites resulted from vandalism because of increased knowledge of the presence of these sites.

API 2-11 The BOEM believes the statement remains accurate whether one is considering the direct effects of the dispersant or indirect effects from changes in oil particle size, and there would seem little to be gained by distinguishing between two unknowns. Nor is there any implied conclusion that effects, if they exist, can be distinguished as positive or negative for the preservation of shipwrecks.

API 2-12 As per reviewer's suggestion, BOEM has incorporated the more recent May 12, 2011, data in **Tables 4-8 and 4-12** and in numbers cited throughout the Final Multisale EIS.

API 2-13 The inclusion of relevant references as indicated by API would not have altered the conclusions. The references as provided in the comment by API appear to represent preliminary results and are not final in nature. Referenced at the end of this sentence are three tables (**Tables 4-8, 4-12, and 4-13**) and two figures (**Figures 4-16 and 4-17**), which include relevant information to this discussion. The following several sentences in the Draft Multisale EIS on page 4-269 were included to further provide support to the conclusions herein, recognizing uncertainty and unavailable information. The literature review conducted for the analysis was extensive, but the subject-matter expert had to make decisions on what references and studies were the most useful for the decisionmaker and public in evaluating a proposed action and alternatives, and at some point the subject-matter expert had to conclude the analysis for the final preparation of the Final Multisale EIS. The analysis for the coastal and marine bird sections in the Draft Multisale EIS represent a synthesis of over 400 references, of which nearly 300 were from 100 different scientific peer-reviewed journals, as well as over 50 government reports.

API 2-14 The BOEM recognizes that the eastern brown pelican was delisted in November 2009 (now considered formally recovered under ESA by FWS). However, given its life-history strategy (**Table 4-13**), the number of individuals collected (n = 932) and its oiling rate (40%; **Table 4-8**), as well as potential effects to food resources for this species, it seemed prudent to consider the eastern brown pelican under the section for threatened and endangered species. In their review of the references cited by API, BOEM subject-matter experts determined that this information is certainly relevant, but ultimately it would not change the conclusions regarding this species. The subject-matter expert had to make decisions on what references and studies were the most useful for the decisionmaker and public in evaluating a proposed action and alternatives, and as such, not every relevant reference was included for this reason.

API 2-15 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-16 Comments noted. The BOEM has decided to retain the least tern, piping plover, bald eagle, and eastern brown pelican in **Table 4-14**, but include footnotes with clarification on status, where appropriate.

API 2-17 **Table 4-8** includes superscript b, which states, "Note: Though the process was triggered by the DWH oil spill, not all birds recovered were oiled (39% = oiled, 50% = unoiled, 11% = unknown), suggesting that 'search effort' alone accounted for a large proportion of the total (*n* = 8,066) birds collected (see Piatt et al., 1990a, page 127). Some of the live birds collected may have been incapable of flight due to age or molt, and some of the dead birds collected may have died due to natural mortality, predation, or other anthropogenic sources of mortality." This statement qualifies the data associated with the table and some of the statements in the text. With regards to API's second point on collections in Florida, BOEM is not aware of publicly available information on the collection of birds on Florida's Atlantic Coast during the period following the DWH event, where birds may have been impacted by the event. See, for example, **Figure 4-15**, "Dead Bird Recovery Locations," in which one can see there are no dots (denoting where varying numbers of birds collected at a given geospatial point) associated with the Atlantic Coast of Florida. Refer also to the link below provided from the Fish and Wildlife Service's DWH website (http://www.fws.gov/home/dhoilspill/pdfs/DeadDensity20101214.pdf), which is the same as **Figure 4-15** in the Draft Multisale EIS, but in color. There are no dots indicating any dead birds were recovered (and included) from the Atlantic Coast of Florida.

API 2-18 Comment noted. See the response to comment API 2-17. From the text provided in the Final Multisale EIS, the data provided for each species include the following: # collected; # visibly oiled; and oiling rate (as a percentage). Refer also to **Tables 4-8 and 4-12** for additional information and clarification.

API 2-19 Comment noted. As BOEM states throughout the Final Multisale EIS, this "total" will ultimately represent some presently unknown fraction of total DWH-related, oil-spill mortality. The scientific literature is abound with numerous examples of various spills in which carcass counts constitute a small, but unknown, fraction or proportion of total mortality for a myriad of reasons. Refer to **Table 4-8** superscript 1 and **Table 4-15** and associated footnotes, as well as the references provided with each table.

API 2-20 Comments noted. Though BOEM cites Burger (1993) in a number of places in the Draft Multisale EIS, nowhere does BOEM reference to the "rule of thumb" being 10x the body count in the Draft Multisale EIS. The BOEM would agree that each spill should be examined independently, but in the absence of available data or limited data, one can provide a reasonable "range of estimates" given the published literature. Ultimately, the NRDA process and associated research and modeling efforts will likely provide a reasonable estimate of total avian mortality. However, that information is not available at the time the Final Multisale EIS is being finalized and may not be available for years to come. Therefore, BOEM relied upon the Fish and Wildlife Services's DWH Collection Report data and the published literature.

Regarding API's second point, see the response to comment API 2-17. It should also be noted that the total body count and the total modeled estimate of avian mortality from an oil spill does a poor job of indicating "effect" or "impact" to a given species' population, as not all birds are created equal (i.e., reproductive age females are "worth" more to the recovery and ultimate size of the population). To address this, some form of calculating/deriving lost-bird-years and recovery to baseline conditions is necessary and requires knowledge of the age-sex composition of the oiled sample of birds, as well as age-sex structure of the target population. See **Chapters 4.1.1.14.1 and 4.2.1.16.1** for additional information regarding compensatory mitigation for impact avian species following oil spills.

API 2-21 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-22 Another study showed significant damage to a coral community at 7 mi (11 km) distance from the wellhead. But this seems to be a rather isolated occurrence; mostly, oil appears to have remained in the water column long enough for thorough degradation by bacteria (USDOI, BOEMRE, 2010j).

API 2-23 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-24 The creation of microdroplets by an oil release under high pressure is stated and clarified in numerous locations throughout the document. This one just states that use of dispersant at depth increases the risk to benthic communities. The BOEM believes the statement remains accurate. The description of the damaged coral community is accurate and merely points out the obvious potential connection with the oil spill. It is now updated to incorporate the results of White et al. (2012); the results suggest that Macondo oil is present on the damaged corals.

API 2-25 The document addresses potential effects of a proposed action, to compare with impacts from the alternatives. A subsea plume of oil could reach the seafloor and contact sensitive benthic communities. The same paragraph states, "Depending on how long it remains in the water column, oil may be thoroughly degraded by biological action before contact with the seafloor. Water currents can carry a plume to contact the seafloor directly but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall . . . . The BOEM believes the statement remains accurate.

API 2-26 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-27 General references discussing possible sublethal effects to corals are included in the Final Multisale EIS. These statements provide a description of possible direct contact with an oil plume on the seafloor.

API 2-28 The study of chemosynthetic communities started in the Gulf of Mexico in the 1980's. The existence of scores of communities has been verified. However, recent BOEM work suggests the locations of thousands of possible hard bottoms created by chemosynthetic activity.

API 2-29 This work is available on BOEM's website and a citation has been added to the Final Multisale EIS. The number is now over 16,000. The number was corrected in the Final Multisale EIS.

API 2-30 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-31 The results of the study have yet to be released to the public. Without the study results, one cannot speculate that no damage has occurred to the habitats under investigation.

API 2-32 The text in the Final Multisale EIS has been revised where appropriate.

API 2-33 The word "alleged" was used because no statement was made that this was supported by science or that any anoxic conditions would occur in the future. It was simply meant to address those concerns that were being advanced by some of the scientific community at the time of the spill.

API 2-34 The sentence contained the qualifier that "it has been suggested." These allegations were made by researchers in the field after the BP spill. There was never a statement made that their scientific validity was accepted. The succeeding paragraphs qualify this statement.

API 2-35 The discussion of McAuliffe information is a peer-reviewed article that corroborates the evidence of Lubchenco et al. (2010). Lubchenco et al. indicate that dispersed surface oil comprised oil in the water column down to a 6-m (20-ft) depth. The last sentence of the excerpt states that the range was in ppm and even less and that the gradient of oil concentration decreased with distance from the well and with depth (for surface oil). The BOEM believes the statements in the Final Multisale EIS remain accurate.

API 2-36 The BOEM believes that the statement remains accurate, in the context of that same paragraph where additional clarification is provided.

API 2-37 Oil and oil products can be detected in the bodies of larvae, fecal pellets, and sediment. It is understood that the oil undergoes changes as it weathers and biodegrades. The Final Multisale EIS is not intended to delineate the chemical pathways of oil degradation; thus, it refers to oil and its subsequent products in general terms useful to the decisionmaker and public in evaluating a proposed action and alternatives.

API 2-38 Comment noted. The text of the Final Multisale EIS has been revised to address the comment. It is recognized that oil in the water column would undergo changes as it weathers and biodegrades. The oil and/or its end products would eventually sink to the seafloor in some form. Other text makes it clear that biodegradation and dispersion render the end products, eventually, nontoxic.

API 2-39 Where applicable, clarification on the toxicity of dispersed and undispersed oil was included in the Final Multisale EIS. However, the subject-matter expert believed that the publicly available sampling results do not support the conclusion that "concentrations drop quickly." The BOEM believes the modeling data in the Final Multisale EIS remains accurate.

API 2-40 More detail was provided in the Final Multisale EIS regarding the Hamdan and Fulmer (2011) study. As well, clarification was made that samples were spiked with high dispersant concentrations (>1 mg/L), in comparison, for example, to COREXIT concentrations of 0.01-0.1 mg/L observed between ~1 and 10 km (0.6 and 10 mi) from the wellhead in the subsurface plume (Kujawinski et al., 2011).

API 2-41 The following was added to the text where appropriate: "Note, however, that hypoxic conditions were not reached during the DWH event in the subsurface plume (e.g., OSAT, 2010)."

API 2-42 All comments were incorporated, where appropriate.

API 2-43 The text in the Final Multisale EIS was revised as follows: "percent" was changed to "23 percent of the volume in 48 hours" and " . . . and 73 percent dispersal of the volume in 48 hours is attributed to weathering" was added.

API 2-44 Comment noted. The text of the Final Multisale EIS has been revised for clarification:

API 2-45 A statement was added following the reference to Gentner Consulting Group (2010) in light of this comment. Updated data available since the publication of the Draft Multisale EIS has also been included.

API 2-46 The referenced sentences were deleted as unduly confusing, in light of this comment

API 2-47 Comment noted. The text of the Final Multisale EIS has been revised where appropriate to address the comment.

API 2-48 The statements that reference Oxford Economics (2010) were revised to put that study into context, in light of information that has become available since that report was released.

API 2-49 Commercial landings for all commercial species are not available for 2011 on NOAA's commercial landings site and will not be available until probably August 2012. When they are all available and can be updated comparably, they will be updated and comparisons made.

API 2-50 Comment noted. The citation has been revised in the Final Multisale EIS as "Greater New Orleans, Inc. (2011)."

API 2-51 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-52 The primary discussion of the impacts of the DWH event on the economies along the Gulf Coast occurs in **Chapter 4**. Therefore, BOEM chose to address this comment by clarifying that analysis in **Chapter 4** rather than in **Appendix B**.

API 2-53 Comment noted. The text has been revised, where appropriate. The BOEM subject-matter experts have included the information they deem relevant and important for the decisionmaker and public in evaluating a proposed action and alternatives. Where appropriate, BOEM has taken a conservative approach, assuming potential pathways and risks exist, and, for example, including anecdotal information to supplement traditional peer-reviewed studies or publicly available data.

API 2-54 Comment noted. The text has been revised, where appropriate. The BOEM subject-matter experts have included the information they deem relevant and important for the decisionmaker and public in evaluating a proposed action and alternatives. Where appropriate, BOEM has taken a conservative approach, assuming potential pathways and risks exist, and, for example, including anecdotal information to supplement traditional peer-reviewed studies or publicly available data.

API 2-55 The state of decline of the bluefin tuna can be debated as can the difference in eastern and western Atlantic stocks. The inclusion of a 20-year decline was considered a compromise in the length of time of stock decline.

The Atlantic bluefin tuna was considered for listing with the Convention for International Trade in Endangered Species as an endangered species, which would have limited the ability of the Nation to trade it internationally. This listing was supported by NOAA but opposed by some European nations.

The western Atlantic stock has suffered a significant decline in spawning stock biomass since 1950, and a 20-year rebuilding plan has failed to revive the population or the North American fishery. The failure of the GOM spawning population to rebuild, as well as the scope of illegal and under-reported catches (particularly in the Mediterranean Sea) are of such major concern that the species was recently considered by the Convention for International Trade in Endangered Species for endangered species' listing in March 2010. This listing would have limited international trade of bluefin to nonmember Convention for International Trade in Endangered Species nations.

As a result of a petition by the Center for Biological Diversity, NMFS had announced a 90-day finding for a petition to list Atlantic bluefin tuna as either endangered or threatened and to designate critical habitat under the Endangered Species Act (*Federal Register*, 2011c). On May 27, 2011, NMFS announced that, at this time, the Atlantic bluefin tuna does not warrant species protection under the ESA. Because of their decline in stock from overfishing, the timing of their spawn in the Gulf, their buoyant eggs, and the timing of the DWH event, there is concern about further decline in the western Atlantic stock of bluefin tuna due to potential impacts on the spawning area in the CPA and farther east. The NMFS has, however, committed to review this decision in early 2013 based on a Stock Assessment to be completed in 2012 and pending more information on the DWH event (*Federal Register*, 2011c).

API 2-56 Bullet 1—The text of the Final Multisale EIS was revised to indicate that the Atlantic bluefin tuna stock reduction is not likely to exceed 4 percent. The study by Fodrie and Heck (2011) was added even though this study is cited elsewhere in the Final Multisale EIS.

Bullet 2 – Text regarding the other causes of fish kills was also added to the Final Multisale EIS.

API 2-57 Bullets 1 and 3 – The text of the Final Multisale EIS has been revised to address the comments.

Bullet 2 – Comment noted.

API 2-58 This sentence has been deleted.

API 2-59 Bullet 1 – Concentrations near the wellhead changed.

Bullet 2 – A sentence including Valentine et al. (2010) has been added to the Final Multisale EIS.

API 2-60 The text of the Final Multisale EIS has been revised to address the comment.

API 2-61 Bullet 1 – OSAT 1 was not a definitive study and neither are life benchmarks.

Bullet 2 – The Biloxi *Sun Herald* is not considered scientific literature.

Bullet 3 – Fodrie and Heck (2011) have been quoted and have been used to revise the Final Multisale EIS.

Bullet 4 – The menhaden data were located and have been included in the Final Multisale EIS.

API 2-62 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-63 Shrimp data could not be found on the Internet. All commercial stocks will be updated in the next Supplemental EIS when the landings data are updated, usually at the end of summer.

API 2-64 Comment noted. The referenced sentence was modified to some degree. The subsequent sentence, which refers to the chapter on essential fish habitat for more information on the impacts of the DWH event on fish populations, was maintained.

API 2-65 The newspaper article was confirmed in an email from Dr. Eric Hoffmayer, the leading authority on whale sharks in the Gulf of Mexico.

API 2-66 Comment noted. The text of the Final Multisale EIS was revised where appropriate. The BOEM subject-matter experts have included the information they deem relevant and important for the decisionmaker and public in evaluating a proposed action and alternatives. Where appropriate, BOEM has taken a conservative approach, assuming potential pathways and risks exist and, for example, including anecdotal information to supplement traditional peer-reviewed studies or publicly available data.

API 2-67 The text of the Final Multisale EIS has been revised to put the term "small" in context.

API 2-68 Comment noted. The text in **Appendix B** of the Final Multisale EIS has been revised to address the comment.

API 2-69 The comment erroneously referred to page 4-441 of the Draft Multisale EIS when it should have applied to similar text in the Environmental Justice Chapter (**Chapter 4.2.1.23.4**). The text in **Chapter 4.2.1.23.4** of the Final Multisale EIS has been revised.

API 2-70 Because the purpose of the paragraph is to repeat the health effects reported at the 2010 Workshop, the text has not been revised. The bulk of the discussion regarding health effects is located in **Chapter 4.2.1.23.4** (Environmental Justice) rather than in the air quality discussion.

API 2-71 Comment noted. The text was revised where appropriate. The BOEM subject-matter experts have included the information they deem relevant and important for the decisionmaker and public in evaluating a proposed action and alternatives. Where appropriate, BOEM has taken a conservative approach, assuming potential pathways and risks exist and, for example, including anecdotal information to supplement traditional peer-reviewed studies or publicly available data.

API 2-72 The sentence that workers on adjacent rigs made health complaints following dispersant application was removed. The bulk of the discussion regarding health effects is located in **Chapter 4.2.1.23.4** (Environmental Justice) rather than in the air quality discussion.

API 2-73 Comment noted. The text was revised for clarification throughout the **Chapter 4** sections on environmental justice.

API 2-74 Comment noted. The text was revised for clarification throughout the **Chapter 4** sections on environmental justice.

API 2-75 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-76 The statement remains accurate, as the UME and NRDA evaluation processes remain ongoing. In addition to investigating all other potential causes, scientists are investigating what role *Brucella* may have in the UME, and this effort continues today. As of February 7, 2012, 11 out of 39 dolphins tested to date were positive or suspect positive for *Brucella*. As of April 14, 2012, there have been 723 animals stranded since the UME began. The text of the Final Multisale EIS has been revised to address the comment.

API 2-77 The BOEM believes the statement remains accurate, given the information included in the paragraph: "It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses were related to the DWH oil spill." Also, the dates of the UME are clearly stated in the previous section, which indicate that the event began before the DWH event.

API 2-78 A vast majority of these strandings involving premature, stillborn, or neonatal bottlenose dolphins between Franklin County, Florida, and the Louisiana/Texas border (just west of the CPA) was accurate at the time the document was written (during calving season 2011). Data from 2010 through 2012 are considered preliminary and may be subject to change as more information becomes available from NOAA's website. The text remains as is.

API 2-79 The BOEM believes that the following statement remains accurate as written. As stated in the Final Multisale EIS: "It is therefore unclear whether increases in stranded cetaceans during and after the DWH-event response period are or are not related to impacts from the DWH event, and it will likely remain unclear until NMFS completes its UME and NRDA evaluation processes." The final causes of previous UME's are not relevant in this instance.

API 2-80 The unprecedented efforts by government and others may have raised carcass recovery rates significantly above levels found in normal circumstances. In the Final Multisale EIS, text has been added to clarify that stranding numbers are significantly greater than reported in past years, although it should be further noted that stranding coverage has increased considerably due to the DWH event.

API 2-81 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-82 A citation was provided and clarifying language has been added regarding NMFS reports.

In addition to investigating all other potential causes, scientists are investigating what role *Brucella* may have in the UME, and this continues today. The text of the Final Multisale EIS does not need to be updated.

API 2-83 Bullets 1, 2, and 3 – The BOEM believes that the referenced statement of 3 million gallons of oil remains accurate and will continue to use the 3 million gallon estimate in the Final Multisale EIS instead of changing it to a range of 1 to 3 million gallons.

The BOEM has not added “Hypoxic conditions were not observed post-DWH” after “. . . all carcasses were related to the DWH oil spill.” Hypoxic conditions were observed in 2011 but they are not relevant here, as you stated, “ERCO does not suggest that hypoxic conditions were the result of the spill.”

API 2-84 At the time the document was written, the sperm whales were documented but the cause of death was pending. Clarifying language has been added to the Final Multisale EIS, updating the most recent information released regarding these findings.

API 2-85 The date was revised to July 15, 2010, and the percentages were clarified in the text of the Final Multisale EIS.

API 2-86 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-87 The text was changed in the Final Multisale EIS to state that, of the 4.9 MMbbl of oil released from the well, approximately 17 percent was directly recovered from the wellhead and this oil did not enter the environment.

API 2-88 The distribution would not be a sheet flow or simple diffusion. Distribution would follow water current patterns, which of course, are not in a straight line but can change and even reverse direction. This language has been clarified in the Final Multisale EIS.

API 2-89 The BOEM believes the language in the Final Multisale EIS remains accurate. The SCAT shoreline oiling maps still show the presence of oil along coastal Louisiana. As well, the OSAT-2 (2011) report indicated the following: “In most locations, models predict PAH concentrations in supratidal buried oil will decrease to 20% of current levels within 5 years. However, there are isolated conditions where PAH concentrations are predicted to persist substantially longer.”

API 2-90 This comment has been incorporated in the Final Multisale EIS.

API 2-91 The Reddy et al. (2011) study is included in the Final Multisale EIS.

API 2-92 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-93 Comment noted. The discussion noted the date of the assessment, and BOEM stands by the description used in the analysis.

API 2-94 The statement was removed because no citation was found; this done for WPA and CPA.

API 2-95 Comment noted. The text of the Final Multisale EIS has been revised to address the comment. The BOEM subject-matter experts have included the information they deem relevant and important for the decisionmaker and public in evaluating a proposed action and alternatives. Where appropriate, BOEM has taken a conservative approach, assuming potential pathways and risks exist. As noted in **Chapter 4**, for purposes of this Final Multisale EIS, BOEM has conservatively assumed that fish consumption remains a potential pathway for impacting the local population in the event of a large-scale spill or catastrophic event.

API 2-96 Comment noted. The text of the Final Multisale EIS has been revised to address the comment. The BOEM subject-matter experts have included the information they deem relevant and important for the decisionmaker and public in evaluating a proposed action and alternatives. Where appropriate, BOEM has taken a conservative approach, assuming potential pathways and risks exist. As noted in **Chapter 4**, for purposes of this Final Multisale EIS, BOEM has conservatively assumed that fish consumption remains a potential pathway for impacting the local population in the event of a large-scale spill or catastrophic event.

API 2-97 As BOEM notes in the Final Multisale EIS (as quoted below), the causes of death have not yet been determined. The BOEM acknowledges that it remains possible that some deaths may be attributed to fishing operations or other unknown factors, but that remains under investigation.

"It is also important to note that evaluations have not yet confirmed the cause(s) of death, and it is possible that not all carcasses collected were related to the DWH event oil spill."

API 2-98 Bullets 1, 2, and 3 – Comments noted. The text under the heading of "Sublethal Impacts" has been revised in the Final Multisale EIS to address the comments.

Bullet 4 – OSAT data are already discussed in the last paragraph of the "Sublethal Impacts" section.

API 2-99 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-100 The OSAT results are discussed elsewhere (see pages 4-89, 4-90, 4-155, 4-157, and others of the Draft Multisale EIS). "Wide distribution of small amounts of oil" is accurate and communicates the idea that the oil was likely dispersed to levels low enough to be generally nontoxic. "Scattered microhabitats" refers to the widely distributed small amounts of oil, i.e., a single clump of flocculated sediment/oil/fecal matter that sinks to the seafloor.

API 2-101 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-102 Comment noted. The text of the Final Multisale EIS referred to by API has been deleted to address the comment and reduce confusion.

API 2-103 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-104 Until more data are released, no determinations can be made on the amount of oiled sediment that reached the seafloor. The text is stating that, if large amounts of oil reached the seafloor, benthic communities may be impacted; however, since very little data are currently available, because deposition is frequently patchy, and because widespread sampling efforts do not always locate concentrated areas of deposition, the possibility of localized heavy deposition cannot be ruled out. The next paragraph of the text discussed the OSAT data and the fact that greatest impacts were closest to the well where the highest toxicities of oil were measured.

API 2-105 Bullets 1 and 2 – The text of the Final Multisale EIS has been revised to address the comments.

API 2-106 Comment noted. The BOEM stands by the description used in the analysis.

API 2-107 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-108 Bullets 1 and 2 – Comment noted. The text of the Final Multisale EIS has been revised to address the comments.

API 2-109 Bullet 1 – Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

Bullet 2 – A statement from OSAT-2 was added at the end of the section. This was taken from the summary of the section.

API 2-110 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-111 The WPA and CPA text have been revised, as follows, to reflect photographic evidence of one terrapin that was found oiled:

> As of April 18, 2012, two other reptiles (not yet identified as terrapin and other than sea turtles) have been collected in the CPA (RestoreTheGulf.gov, 2012). There is photographic evidence of one terrapin found oiled on Grand Terre Island, Louisiana, on June 8, 2010 (Coastal Protection and Restoration, 2012). It is not clear whether this terrapin was included with the two reptiles collected in the CPA, described on the RestoreTheGulf.gov (2012).

API 2-112 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-113 The Valentine et al. (2010) study has also been incorporated into the text, and reference was made to the fact that hypoxic conditions were never reached.

API 2-114 The BOEM is not arguing the use of the phrase "clouds of methane," a phrase commonly used in the press at the time, as opposed to "plumes of methane" or "stratified levels of methane." In essence, the meaning of the phrase as used at the time and as used in this EIS means that there were elevated subsurface levels of methane.

API 2-115 This was addressed in the response to comment API 2-59.

API 2-116 Comment noted. The Kessler and Valentine studies have been duly noted and cited in the Final Multisale EIS.

API 2-117 Where appropriate, these comments have been incorporated, including reference to the Ryerson et al. (2011a) and OSAT (2010) studies.

API 2-118 The information provided by API is noted but is more detailed than is necessary for this section of the EIS. Spill behavior is addressed in more detail in other sections of the EIS.

API 2-119 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-120 Bullet 1 – Weathering and biodegradation are discussed in the sentences following the one noted in the comment.

Bullet 2 – Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

Bullet 3 – The discussion in the text does not state that oil remained in the water column. It discussed the weathering and biodegradation of oil.

API 2-121 Bullets 1 and 2 – Comment noted. The text of the Final Multisale EIS has been revised to address the comments.

Bullet 3 – This is a section on "dispersed oil" and therefore the subject of subsea dispersants were discussed as a mode of oil dispersion here. However, physical mixing is also discussed here (as well as in other sections).

Bullet 4 – The BOEM defines deepwater as 300 m and greater (NTL 2009-G40). The subsea plume was in water deeper than 300 m; therefore, the subsea plume was in deep water and not on the continental shelf.

API 2-122 The BOEM believes this statement remains accurate as it was clarified later in the paragraph.

API 2-123 The OSAT results are discussed extensively in the Final Multisale EIS. As noted in the Final Multisale EIS, "[c]oncentrations of dispersed and dissolved oil in the subsea plume were reported to be in the part per million range or less and to decrease with distance from the wellhead."

API 2-124 References are given for the sampling efforts. A full discussion of chemical dynamics is not appropriate here as it would not assist the decisionmaker or public in assessing a proposed action and alternatives, nor alter the conclusions made in the Final Multisale EIS.

API 2-125 This sentence was clarified to clarify that accidental events in general are being discussed, and not just the DWH event.

API 2-126 The first sentence was revised so as to not imply that there will be long-term impacts to offshore water quality, but rather that it is an unknown. This section is addressing offshore water quality, so the references to coastal datasets were not included.

API 2-127 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-128 Comment noted. The text of the Final Multisale EIS has been revised to address the comment.

API 2-129 Bullets 1, 2, 3, and 5 – The text of the Final Multisale EIS has been revised to address the comments.

Bullet 4 – The OSAT-2 has a graphic with SCAT data on the maximum amount of oil found in Louisiana, Mississippi, Alabama, and Florida. Although SCAT was only on land, it is assumed that oil was also in the adjacent waters.

Bullet 6 – The source cited was not used to discuss southern Florida. The portions of the comment dealing with *Sargassum* and turtles are unclear as this is the seagrass section.

API 2-130 Several references have been added to the Final Multisale EIS, where appropriate. Preliminary evidence of clean *Sargassum* is not surprising, since oiled *Sargassum* can be expected to die and sink, while fresh drifts of *Sargassum* float in from the western GOM. As *Sargassum* dies and begins to decay, its bladder floats (pneumatocysts), loses integrity, and allows the algae to sink. Such clumps have been photographed in the deep sea.

Center for Regulatory Effectiveness' ("CRE") Comments on
Bureau of Ocean Energy Management's ("BOEM")
Draft Environmental Impact Study ("DEIS")
For Gulf of Mexico (GOM), Outer Continental Shelf (OCS),
Western Planning Area (WPA) and Central Planning Area (CPA);
Oil and Gas Lease Sales for 2012–2017,
http://www.gpo.gov/fdsys/pkg/FR-2011-12-30/pdf/2011-33605.pdf .
Comments filed electronically on February 13, 2012, to ***MultisaleEIS@BOEM.gov***

CRE-1

CRE appreciates the opportunity to comment on this DEIS. CRE offers the following recommendations to BOEM: (1) the final EIS should reflect the conclusion that seismic does not adversely affect marine mammals under current BOEM regulations; (2) any new, significantly more stringent seismic regulations issued by BOEM will require a new proposed Information Collection Request (ICR); and (3) BOEM should further encourage the use of PAMGUARD as part of the protected species observer program.

I. Seismic Under Current Regulation Causes No Harm

BOEM recently issued a Final Supplemental Environmental Impact Statement for Gulf of Mexico OCS Oil and Gas Lease Sale: 2012; Central Planning Area Lease Sale 216/222; Mexico OCS Oil and Gas Lease Sale: 2012; Central Planning Area Lease Sale 216/222 ("SEIS"). This final SEIS for the GOM correctly states that

> "Overall, within the CPA [Central Planning Area], there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting marine mammal populations. Therefore, in light of the above analysis on the proposed action and its impacts, the incremental effect of the proposed action on marine mammal populations is not expected to be significant when compared with all other past, present, and reasonably foreseeable future activities."[1]

This final SEIS for the GOM further states that

[1] Page 4-231 of document available online at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx

> "the proposed action, would result in negligible effects from the proposed drilling activities on sea turtles. In addition, NTL 2007-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimizes the potential of harm from seismic operations to sea turtles and marine mammals; these mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source. Therefore, no significant cumulative impacts to sea turtles would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area."[2]

CRE agrees with BOEM that seismic does not harm marine mammals or sea turtles or anything else under current regulation.

The National Marine Fisheries Service ("NMFS") recently issued a biological opinion for a seismic Take application under the Marine Mammal Protection Act. This BiOp concluded that the Sperm Whale Synthesis Report and other studies suggest that seismic does NOT affect Sperm Whale behavior such as foraging:

> "These studies suggest that sperm whales exhibit considerable tolerance of seismic sources (*e.g.*, no apparent disruption of behaviors such as foraging or calling), or possibly some degree of habituation."[3]

NMFS' biological opinion also concludes that:

> "The evidence available leads us to conclude that exposure to seismic pulse energy from the proposed seismic activities is not likely to cause a reduction in an individual whale's growth, survival, annual reproductive success, or lifetime reproductive success (i.e., fitness). As a result, we do not expect the proposed action to have an effect on the extinction risk of the population(s) these individuals represent or the whale species these population(s) comprise."[4]

These conclusions are consistent with recent BOEM actions. For example, BOEM's Supplemental Environmental Impact Statement for proposed oil and gas Lease Sale 218 in the GOM Western Planning Area ("WSEIS") contains an extensive discussion of sperm whales, other marine mammals, and sound. This WSEIS correctly concludes:

[2] *Id.*, page 4-242

[3] Pages 73-74 of NMFS biological opinion available online at http://www.nmfs.noaa.gov/pr/pdfs/consultations/biop_usgs2011.pdf

[4] *Id.* at page 86.

> "In addition, NTL 2007-G02, 'Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program,' minimizes the potential of harm from seismic operations to marine mammals. These mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source. Therefore, no significant cumulative impacts to marine mammals would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area."[5]

The WSEIS correctly concludes, "Marine mammals may exhibit some avoidance behaviors, but their behavioral or physiological responses to noise associated with the proposed action, however, are unlikely to have population-level impacts to marine mammals in the northern Gulf of Mexico."[6]

MMS/BOEM and the National Research Council have similarly concluded:

> "[T]here have been no known instances of injury, mortality, or population level effects on marine mammals from seismic exposure but… the potential for these types of impacts may exist without appropriate mitigation measures. The MMS-approved seismic surveys include mitigation measures designed to reduce the potential for effects to occur."[7]

NMFS has also emphasized that "to date, there is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to airgun pulses, even in the case of large airgun arrays."[8]

NMFS' conclusions are supported by the results of recent controlled sound exposure experiments on a sperm whale, which concluded:

> "In neither CEE [controlled sound exposure experiment] did this individual appear to demonstrate obvious behavioral responses, as seen in the dive profiles

5 Page 4-150, http://www.gomr.boemre.gov/PDFs/2011/2011-034-v1.pdf
6 Page 4-145, http://www.gomr.boemre.gov/PDFs/2011/2011-034-v1.pdf
7 See, e.g., Outer Continental Shelf Oil & Gas Leasing Program,2007-2012 Final Environmental Impact Statement, page V-64 (MMS April 2007), available at http://www.boemre.gov/5-year/2007-2012DEIS/VolumeII/5and6-ConsultationPreparers.pdf
8 75 FR 49795-96 (Aug. 13, 2010), page 49795, available at http://edocket.access.gpo.gov/2010/2010-19962.htm .

> below; no clear changes in the production of echolocation clicks were observed in either case.[9]

II. A New ICR Would be Necessary for Any Significant Change from Current Seismic Regulation

CRE has previously filed two comments that are relevant to the DEIS and seismic. BOEM's response to these comments agrees with CRE on an important point—BOEM will have to prepare a new Information Collection Request ("ICR") for public comment and for Office of Management and Budget ("OMB") review before BOEM could regulate seismic in a manner that is significantly different from current regulation under NTL No. 2007-G02.

First, on September 30, 2011, BOEM published Federal Register notice that BOEM was submitting an ICR to OMB for review. This FR notice also responds to comments that CRE submitted on BOEM's draft ICR. This ICR is for regulations that apply to offshore seismic.[10]

Second, on October 21, 2011, BOEM published Federal Register notice that BOEM was submitting another ICR to OMB for review. This FR notice responds to comments that CRE submitted on BOEM's draft ICR. This ICR is also for regulations that apply to offshore seismic.[11]

BOEM's September 30th FR notice explains:

> "We received two comments in response to the Federal Register notice. The first comment, from the Marine Mammal Commission, supported our request to OMB. The second comment, from the Center for Regulatory Effectiveness, requested that we should state that we are not submitting any ICRs for seismic regulations that are more stringent than current regulations, including NTL 2007-G02.
> Response: For the renewal of this ICR, we are not requesting anything more

9 Biological and Behavioral Response Studies of Marine Mammals in Southern California, 2010 ("SOCAL-10"), Project Report, 26 February 2011, page 24, available online at http://www.cascadiaresearch.org/reports/SOCAL10_final_report-2010.pdf.
10 BOEM's September 30, 2011 Federal Register notice of the ICR's submission to OMB is available online at http://www.gpo.gov/fdsys/pkg/FR-2011-09-30/html/2011-25262.htm. The OMB file for this ICR is available online at http://www.reginfo.gov/public/do/PRAViewICR?ref_nbr=201108-1010-003 .
11 BOEM's October 21, 2011 Federal Register notice of the ICR's submission to OMB is available online at http://www.gpo.gov/fdsys/pkg/FR-2011-10-21/html/2011-27331.htm . The OMB file for this ICR is available online at http://www.reginfo.gov/public/do/PRAViewICR?ref_nbr=201106-1010-004 .

stringent than in current NTL 2007-G02 and 30 CFR 250, subpart B regulations, which are covered under OMB Control Number 1010-0151. We have no plans, at this time, to change the content of or the resultant burdens imposed by NTL 2007-G02. Therefore, BOEMRE should move forward with the required information collection to ensure compliance with OMB deadlines. If the lawsuit settlement or resulting decree requires changes to the NTL and/or DOI regulations, information collection coordination and OMB approval will occur before any NTL is reissued or regulations are promulgated."[12]

Similarly, BOEM's October 21st Federal Register Notice explains:

"We received two comments in response to the Federal Register notice. The first commenter, the Marine Mammal Commission stated that it was in support of our submission to OMB. The second commenter, Center for Regulatory Effectiveness, requested two actions. One, that we should state that we are not submitting any ICR for seismic regulations that is more stringent than current regulations, including NTL 2007-G02. Response: For the renewal of this ICR, we are not requesting anything more stringent than in current 30 CFR 551 regulations; NTL 2007-G02 is covered under OMB Control Number 1010-0151. Second, that we wait to submit the ICR to OMB. There is current on-going litigation pertaining to seismic regulations (BOEM vs environmental plaintiff(s)). Response: This particular ICR renewal pertains mostly to revising the form currently in use due to new developments in technology; we are not requesting any new requirements. If the lawsuit settlement or decree requires changes to the form and/or DOI regulations, information collection coordination and OMB approval will occur before the form is reissued or regulations are promulgated.[13]

The referenced NTL No. 2007-G02 is entitled "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program." This NTL explains that

"[It] clarifies how you should implement seismic survey mitigation measures, including ramp-up procedures, the use of a minimum sound source, airgun testing and protected species observation and reporting. The measures contained herein apply to all on-lease surveys you conduct under 30 CFR 250 and all off-lease surveys you conduct under 30 CFR 251." [14]

In the above-quoted Federal Register notices, BOEM responds to CRE comments which explain in greater detail that environmental group plaintiffs are suing BOEM in New Orleans federal

[12] http://www.gpo.gov/fdsys/pkg/FR-2011-09-30/html/2011-25262.htm , page 60861.
[13] http://www.gpo.gov/fdsys/pkg/FR-2011-10-21/html/2011-27331.htm , page 65523.
[14] Available online at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/2007NTLs/07-g02.pdf

Center for Regulatory Effectiveness

court over regulation of seismic in the GOM. CRE's ICR comments state concerns regarding the regulatory impact of any settlement, and the need for public comment on and OMB review of any such impact.

CRE's ICR comments further state that, for at least two reasons, BOEM should not send OMB any revised ICRs for seismic regulation that is more stringent than currently imposed. First, BOEM has repeatedly and correctly stated that current regulation of seismic adequately protects the environment. In other words, current regulation of seismic is all that's necessary for the proper performance of BOEM's functions. Therefore, under the Paperwork Reduction Act ("PRA") BOEM should not submit, and OMB should not approve, ICRs for more stringent seismic regulation. Such ICRs would violate the PRA because they would be unnecessary for proper performance of BOEM's functions.

Any ICRs for more stringent seismic regulation would also violate the accuracy requirement of BOEM's Data Quality Act ("DQA") Guidelines. The PRA requires that BOEM certify that ICRs are necessary for the proper performance of BOEM's functions. That certification would be inaccurate in the case of ICRs for more stringent seismic regulation. Current regulation of seismic, and ICRs based on current regulation, are all that is necessary for proper performance of BOEM's functions.

CRE-2

CRE's comments on these two ICRS are incorporated by reference into these comments by CRE on the DEIS. [15] CRE recommends that BOEM should strengthen the DEIS by stating more clearly that current regulation of seismic prevents harm and that any significant change to current regulation will be preceded by a new proposed ICR, public comment, and OMB review.

III. BOEM SHOULD FURTHER ENCOURAGE PAMGUARD USE

BOEM regulates offshore oil & gas seismic operations primarily through NTL No. 2007-G02, which has a section that encourages, but does not require, the voluntary or "experimental" use of Passive Acoustic Monitoring (PAM):

[15] CRE's comments on the September 30th ICR are available in www.regulations.gov, Docket ID # BOEM-2011-0011-0003 , http://www.regulations.gov/#!documentDetail;D=BOEM-2011-0011-0003. CRE's comments on the October 21st ICR are available in www.regulations.gov, Docket ID # BOEM-2011-0036-0003, http://www.regulations.gov/#!documentDetail;D=BOEM-2011-0036-0003 .

"Experimental Passive Acoustic Monitoring

Whales, especially sperm whales, are very vocalne mammals, and periods of silence are usually short and most often occur when these animals are at the surface and may be detected using visual observers. However, sperm whales are at the greatest risk of potential injury from seismic airguns when they are submerged and under the airgun array. Passive acoustic monitoring appears to be very effective at detecting submerged and diving sperm whales, and some other marine mammal species, when they are not detectable by visual observation. MMS strongly encourages operators to participate in an experimental program by including passive acoustic monitoring as part of the protected species observer program. Inclusion of passive acoustic monitoring does **not** relieve an operator of any of the mitigations (including visual observations) in this NTL **with the following exception**: Monitoring for whales with a passive acoustic array by an observer proficient in its use will allow ramp-up and the subsequent start of a seismic survey during times of reduced visibility (darkness, fog, rain, etc.) when such ramp-up otherwise would not be permitted using only visual observers. If you use passive acoustic monitoring, include an assessment of the usefulness, effectiveness, and problems encountered with the use of that method of marine mammal detection in the reports described in this NTL. A description of the passive acoustic system, the software used, and the monitoring plan should also be reported to MMS at the beginning of its use."[16]

The International Association of Oil and Gas Producers Joint Industry Project ("JIP") has developed and made publicly and freely available a version of PAM which has been tried and tested. This open source method of monitoring marine mammals is called PAMGUARD.

CRE requests that BOEM revise NTL 2007-G02 to encourage the use of PAMGUARD "as part of the protected species observer program." This would not be a significant change in current regulation given the already existing paragraph on PAM that is quoted above.

The PAMGUARD web site discusses PAMGUARD in considerable detail, and provides free, public access to PAMGUARD.[17] The site is worth quoting at some length:

"Background

The PAMGUARD project was set up to provide the world standard software infrastructure for acoustic detection, localisation and classification for mitigation

[16] NTL 2007-G02, http://sero.nmfs.noaa.gov/sf/deepwater_horizon/Appendix_A_Seismic_NTL_2007-G02.pdf (emphasis in the original).

[17] The industry-sponsored PAMGUARD website is available online at http://www.pamguard.org/home.shtml.

Center for Regulatory Effectiveness

against harm to marine mammals, and for research into their abundance, distribution and behaviour. Many marine activities involve underwater sound emissions. These may be a by-product of the activity (e.g. piling or explosives), or a tool (e.g. air guns used for seismic surveys in oil and gas exploration, or military/commercial sonar). To mitigate against harm to marine mammals, observers are often employed to visually scan the sea surface for the presence of animals. In the event of a sighting, procedures such as suspension/delay of activities may be implemented to avoid harm.

Current Methods

Visual observations play a vital role, but marine mammals are difficult to spot on the sea surface, especially when weather and light conditions are poor. However, many marine mammals produce loud and distinctive vocalisations, which can often be detected more reliably than visual cues. For these species, passive acoustic monitoring (PAM) offers an effective means of detection. Furthermore, the creatures do not need to be on the surface to be detected.

Why do we need PAMGUARD?

While PAM software already exists, the source code is not freely available for others to help to expand and improve. This means that assumptions, and therefore margins for error, are not readily understood, that code evolves more slowly, or not at all, and source code improvements are at the mercy of the time and resources that the few responsible developers can commit. In the case of the military and some commercial organisations, detection, classification and localisation (DCL) technologies are in-house and protected. What is needed is an environment which raises the profile of PAM and creates a means of tapping into the intellectual resources of the research community. Industry and marine environmentalists are well aware of the need to upgrade and modernize."[18]

The Joint Industry Program Annual Report for 2009 also contains extensive, detailed documentation of PAMGUARD.[19] The report explains:

"A software package called PAMGUARD has been released that can interpret and display calls of vocalising marine mammals, locate them by azimuth and range and identify some of them by species. These abilities are critical for detecting animals within safety zones and enabling shut-down."[20]

[18] PamGuard site available at http://www.pamguard.org/background.shtml

[19] See 2009 Report, pages 1, 2, and 3, available online at http://www.soundandmarinelife.org/Site/Basics/AnnRep3.pdf.

[20] *Id. at 1.*

Center for Regulatory Effectiveness

PAMGUARD was discussed at a recent IAGC meeting, which strongly encouraged the industry to use PAMGUARD and explained its benefits. [21] One power point slide explains the "PAMGUARD Vision" and outlines why the software should be implemented on a widespread basis:

"• Create an integrated real-time PAM software infrastructure
  --Open source
  --Platform independent
  --Freely available to all PAM users for the benefit of the marine environment.
  --Establish a reliable/robust industry standard interface tool in preparation for PAM being mandated."[22]

CRE-3

BOEM should encourage the use and support of PAMGUARD in BOEM's NTLs and wherever else appropriate. BOEM should, however, recognize that there has been progress in the "development and refinement" of PAMGUARD since the JNCC issued its seismic guidelines.

CRE will be pleased to work with BOEM and further assist the Agency's incorporation of PAMGUARD into the NTL and elsewhere.

We once again thank BOEM for the opportunity to submit these comments, and we look forward to BOEM's response.

Respectfully Submitted,
Jim Tozzi

Member, Board of Advisors

[21] See, beginning with slide 9, power point presentation at http://iagc.org/attachments/contentmanagers/9530/6%207%20IAGC_HSESForum_pres_MarEnv_SMLWkgrpUpdate_V01_2011_09_27.pdf

[22] *Id.* at Slide 11.

Center for Regulatory Effectiveness

CRE-1 The BOEM states in **Chapter 4** that NMFS is preparing an EIS for seismic activities in the GOM and any of CRE's recommendations submitted in that NEPA process will be considered.

CRE-2 The NEPA process for seismic activities in the GOM will consider any new significant changes to existing mitigations. The BOEM and BSEE have mitigations in place (e.g., NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program") that require G&G operators conducting seismic operations in all Federal waters >200 m (656 ft) deep in the CPA and WPA and in all Federal waters of the EPA (regardless of water depth) to (1) employ ramp-up, (2) utilize trained protected species observers, and (3) complete BSEE reporting requirements.

CRE-3 Passive acoustic monitoring is highly encouraged. The BOEM/BSEE fully supports its use, and its application in the GOM is continuing to be evaluated in the NEPA process led by NMFS for associated seismic activities.

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WATERKEEPER® ALLIANCE MEMBER

February 15, 2012

Mr. Gary D. Goeke
Chief, Regional Assessment Section
Office of Environment (MS5410)
Bureau of Ocean Energy Management
Gulf of Mexico OCS Retion
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

RE: Gulf of Mexico OCS Oil and Gas Lease Sales, 2012-2017

Dear Mr. Goeke:

Mobile Baykeeper and Waterkeeper Alliance present the following comments pertaining to the draft environmental impact statement for the proposed Outer Continental Shelf oil and gas lease sales in the Western Planning Area and the Central Planning Area of the Gulf of Mexico.. Mobile Baykeeper is a 15-year-old nonprofit organization with the mission of providing citizens a means to protect the beauty, health and heritage of the Mobile Bay watershed, Alabama's waterways and coastal communities. Waterkeeper Alliance is a global environmental movement uniting more than 190 Waterkeeper organizations around the world and focusing citizen advocacy on the issues that affect our waterways, from pollution to climate change. Waterkeepers patrol more than 1.5 million square miles of rivers, streams and coastlines in the Americas, Europe, Australia, Asia and Africa.

In the comments submitted by Mobile Baykeeper in March 2011 related to the Notice of Intent to put forth a Programmatic EIS for Oil and Gas Leases, we recommended that in preparing the EIS that the recommendations of the Oil Spill Commission be incorporated, long term impacts from the Oil Disaster in the Gulf of Mexico to the Gulf Coast be adequately evaluated, and the need for a citizens advisory committee to be utilized in the creation of the Programmatic EIS. In Mobile Baykeeper's letter of January 9, 2012, we acknowledged that those recommendations have been considered, with long term Oil Disaster impact consideration noted throughout the document as well as Oil Spill Commission guidance incorporated. While the citizens advisory committee was not formed, we acknowledged the seeking of input from stakeholders and the opportunities to provide feedback and comment.

We have seen a worst case scenario in oil and gas exploration in the form of the BP Deepwater Horizon Oil Disaster and we were shown that the oil and gas industry was ill prepared to address such an occurrence. Drilling is now taking place in more remote deepwater locations as traditional reserves are depleted and demand for oil increases, but the advance of emergency preparedness and technology to remedy worst case incidents does not match the advance of extraction technology within the oil and gas industry. As was noted in the draft Programmatic EIS, the response to the Deepwater Horizon event as well as governmental review of industry response indicates mitigation has not matched

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fossil fuel extraction technology in deep water. We understand the Bureau's assessment that the inclusion of new information (and any subsequent requirements) related to spill response and drilling safety would be included through the promulgation of regulations, notices to lessees and operators, and site-specific mitigations identified in NEPA analyses at the lease sale and project levels. The incorporation of additional regulations and guidance is vital to ensuring safe operations of oil and gas extraction in the Gulf of Mexico.

Mobile Baykeeper asserted in our letters of March 2011 and January 2012 that it is essential to understand the full cost of the BP Deepwater Horizon Oil Spill to the Gulf of Mexico, Gulf Coast states, and the nation as a significant and precedent setting event when considering extending offshore drilling leases. Catastrophic events such as this, though statistically rare, are possible and have been proven to be environmentally and economically devastating to the Gulf Coast. In our review of the Programmatic EIS, we noted the potential employment impacts of the extension of the oil and gas industry on the Gulf of Mexico, along with current employment. It was noted that the proposed option in the Programmatic EIS found that the impacts to local economies employment would be minimal with the expansion of leases. It was also noted that current employment related to oil and gas in the Gulf States is roughly 62,000 people, with the most of those jobs located in Texas and Louisiana. In comparison, the recreation and tourist industries employ roughly 1,000,000 people across the Gulf Coast. While we understand the oil and gas leasing program's importance in ensuring adequate energy resources for the nation, it is important to recognize the oil and gas industry's potential to impact the health other industries, as was clearly displayed by the 2010 Deepwater Horizon Event.

We urge BOEM to not forget the hard lessons learned from the BP Deepwater Horizon Oil Disaster when deciding the future of offshore drilling in U.S. Coastal waters. We reiterate that the environmental, economic, and human impacts to the Gulf Coast and its millions of residents created by the massive release of oil into the Gulf of Mexico linger to this day and will continue to negatively impact our communities for many years to come. While a single event, the potential for huge impacts from oil and gas spills to the Gulf Coast is an inherent risk with oil and gas exploration and extraction.

We thank the Department of the Interior's Bureau of Ocean Energy Management for the opportunity to share our thoughts and recommendations on the proposed 2012-2017 OCS oil and gas lease sales in the Gulf of Mexico's Western and Central Planning Areas. Please feel free to contact us for any additional information as presented in these comments.

Thank you in advance for consideration of these comments.

Sincerely,

Donna Jordan
Program Director
Mobile Baykeeper

Justin Bloom
Eastern Regional Director
Waterkeeper Alliance

OCEANA, CENTER FOR BIOLOGICAL DIVERSITY,
CENTER FOR WATER ADVOCACY, DEFENDERS OF WILDLIFE,
GULF RESTORATION NETWORK, OCEAN CONSERVATION RESEARCH,
SIERRA CLUB, SOUTHERN ENVIRONMENTAL LAW CENTER

February 15, 2012

Via Email

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RE: Draft Environmental Impact Statement for 2012-2017 Gulf of Mexico OCS Oil and Gas Lease Sales (Fed. Reg. Doc. 2011-33605)

Dear Mr. Goeke:

Oceana appreciates the opportunity to comment on the Draft Environmental Impact Statement for the 2012-2017 Gulf of Mexico Outer Continental Shelf ("OCS") Oil and Gas Lease Sales ("Multisale DEIS"). The Multisale DEIS is the first Gulf-wide environmental analysis of offshore drilling activities since the catastrophic Deepwater Horizon spill. Because of the recent disaster and the far-ranging impacts of the proposal, it is even more important that this EIS take a hard look at the environmental impacts of the government's offshore leasing program than with an ordinary EIS. Notwithstanding the crucial importance of this EIS, the DEIS resorts to a series of cheap statistical tricks and transparently sophistical arguments to sweep the impacts of the Deepwater Horizon disaster and the potential impacts of the proposed action under the rug. Moreover, BOEM released the Multisale DEIS in the middle of the comment period for the 5-Year Program and its accompanying EIS, seemingly without any expectation that the 5-Year Program, and the ten Gulf lease sales proposed to be held under that program, would not be altered as a result of comments received through that process. Thus this DEIS presents a "no look" rather than a "hard look" analysis.

These comments identify numerous serious flaws in the Multisale DEIS that the agency must correct in the Multisale Final EIS.

OCEANA 1-3

- The analysis of spill risk downplays or ignores the risk of large oil spills.
- The analysis of the impacts of an oil spill (the "mass balance" analysis) fails to take a hard look at the impacts of the most serious types of spills.
- The analysis of impacts on threatened and endangered species fails to take a hard look at the consequences of unlawfully refusing to engage in formal consultation.

OCEANA-4-7

- The analysis does not consider a full spectrum of reasonable and feasible alternatives to the proposed action.
- The analysis mishandles incomplete and missing information.
- The analysis fails to take a hard look at the short- and long-term tradeoffs involved in the proposed action, including the impacts of greenhouse gas emissions.
- The analysis fails to take a hard look at the persistent shortcomings in the regulation and safety of offshore oil and gas drilling.

BOEM must correct these serious flaws in the Multisale Final EIS to fulfill the National Environmental Policy Act's ("NEPA") mandate of taking a hard look at the environmental impacts of a proposed action to inform the public and government decision-makers. If the Final EIS fails to take such a hard look, any decision concerning the balancing required by the Outer Continental Shelf Lands Act ("OCSLA") among "the potential for environmental damage, the potential for the discovery of oil and gas, and the potential for adverse impact on the coastal zone"[1] will necessarily be arbitrary and capricious.

OCEANA-1

I. THE OIL SPILL RISK ANALYSIS DOWNPLAYS OR IGNORES THE RISK OF LARGE OIL SPILLS.

Through the use of cheap statistical tricks, the oil spill risk analysis downplays or ignores the risk of large oil spills. Specifically, the DEIS

- trivializes the effects of the Deepwater Horizon disaster;
- underestimates the risk of accidental oil spills; and
- misstates the total potential volume of oil spilled offshore.

A. The DEIS Trivializes the Effects of the Deepwater Horizon Disaster.

The Multisale DEIS trivializes the effects of the Deepwater Horizon disaster by irrationally omitting from the oil spill risk analysis the largest spill size category, ≥ 10,000 barrels ("bbl"), under which the Deepwater Horizon disaster would fall, even though

- the spill size category was included in analyses for prior EISs, and
- BOEM's analysis relied on studies which included the category.

Moreover, further hiding the effects of the Deepwater Horizon disaster, the Multisale DEIS's analysis uses median spill size as the key parameter, even though the analyses it relies on also reported the arithmetic mean spill size. By irrationally departing from both the methodology of prior analyses and the methodology of the current analyses that it relied on, as well as by

[1] 43 U.S.C. § 1344(a)(3).

OCEANA-1

choosing misleading descriptive statistics, the DEIS manipulates the data to hide the effects of the Deepwater Horizon spill.

1. The ≥ 10,000 bbl spill size category was included in analyses for prior EISs, but omitted from the current DEIS.

DEIS Table 3-12 estimates the mean number and sizes of offshore oil spills that would occur over the 40-year duration of the proposed action. In contrast to prior versions of the same table in earlier Multisale EIS documents, Table 3-12 does not include a ≥ 10,000 bbl spill size category. Indeed, it does not contain any spill size category larger than ≥ 1,000 bbl.

Instead, the analysis incorporates the Deepwater Horizon disaster into the ≥ 1,000 bbl spill size group.[2] The resultant median spill size for the category, the key descriptive statistic the DEIS draws from this analysis, is only 2,200 bbl, even though the Deepwater Horizon disaster spilled 4.9 million bbl.[3] Because of this analysis, the Multisale DEIS's estimate of how much oil will be spilled as a result of the ten proposed lease sales is *less* than that of the 2007-2012 Multisale FEIS, which predated and failed to predict the magnitude of the Deepwater Horizon spill. The current (2012-2017) Multisale DEIS estimates that 200-2,600 bbl and 900-3,900 bbl of oil will be spilled in the Western Planning Area ("WPA") and Central Planning Area ("CPA"), respectively, as a result of the proposed action.[4] In contrast, the equivalent values in the 2007-2012 Multisale FEIS were 400-21,000 bbl and 5,500-26,500 bbl, respectively[5] – more than twice and six times those of the 2012-2017 Multisale DEIS. In large part, this disparity is attributable to the large median spill size for the ≥ 10,000 bbl category in the prior EIS (15,000 bbl) as compared with the current DEIS, which has no such category and a ridiculously small median value used for its largest spill size category (≥1,000 bbl). Recent experience and data[6] indicate

[2] As evidenced by the spill rate for the ≥ 1,000 bbl size group (1.13 spills/BBO), which is the combined spill rates for the ≥ 10,000 bbl and ≥ 1,000 bbl spill size groups in Table 14 of BOEM's updated spill risk analysis. *See* U.S. Dept. of the Interior. Bureau of Ocean Energy Management. 2012. Update of oil spill occurrence rates for offshore oil spills: Draft report. 14 Jan. 2012. Pg. 1, Table 14.

[3] Multisale DEIS at Tables-22 (Table 3-12).

[4] *Id.* at 3-66.

[5] U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Oil and Lease Sales: 2007-2012: Final Environmental Impact Statement, at 4-238.

[6] *See, e.g.*, U.S. Dept. of the Interior. Bureau of Ocean Energy Management. 2012. Update of oil spill occurrence rates for offshore oil spills: Draft report. 14 Jan. 2012. Pg. 1. (, "Spill rates for OCS Platforms doubled when comparing the most recent 15 years data (1996-2010 data) to the last 15 years data in the previous analysis (Anderson & LaBelle 2000: 1985-1999 data) from

OCEANA-1

that spill risks are greater than have been previously estimated. But because BOEM has arbitrarily changed its method of compiling the data, the resulting analysis is arbitrary.

2. The DEIS analysis relied on studies which included the ≥ 10,000 bbl spill size.

While BOEM claims that "meaningful statistics" for the ≥ 10,000 bbl spill size category cannot be calculated, BOEM's own experts calculated statistics for spills ≥ 10,000 bbl. Both of the reports BOEM relies upon in the Multisale DEIS's spill risk analysis include statistics for spills ≥ 10,000 bbl.[7,8] In fact, Ji et al. calculate that the probability of a ≥ 10,000 bbl spill occurring in the CPA alone as a result of *just one* lease sale over a 40 year period is as high as *24%*.[9] Ji et al. also estimate (and the Multisale DEIS acknowledges) that, over the 40 year lifetime of *just one* proposed lease sale, the mean number of ≥ 10,000 bbl spills in the WPA and CPA are 0.04-0.06 and 0.14-0.27 spills, respectively.[10] In other words, the mean aggregate number of ≥ 10,000 bbl spills from all ten proposed lease sales is 0.9-1.65 spills.

The authors of these two reports do not indicate any concern about the validity of the statistics they have calculated for the ≥ 10,000 bbl spill size group, nor do they include any caveats suggesting that the statistics are not "meaningful." BOEM cannot disregard or fail to include these statistics in the Multisale DEIS, unless it has a rational basis for concluding that these statistics are not "meaningful." The only reason that the statistics would not be meaningful would be if the Deepwater Horizon spill – the only data point in the ≥ 10,000 bbl spill size group – was found to be not meaningful, i.e. a statistical outlier. BOEM may not classify the Deepwater Horizon spill as an outlier simply because it is a first-of-a-kind event. Furthermore, because the Deepwater Horizon event is a first-of-a-kind event, BOEM can *not* rely on historical data, as historical data bears no relevance to the probability of such an event (see Section I.B.2). Rather, for BOEM to categorize the Deepwater Horizon event as a statistical outlier, it must provide a

0.13 to 0.25 spills per Bbbl for spills ≥ 1,000 bbl; and from 0.05 to 0.13 spills per Bbbl for spills ≥ 10,000 bbl.")

[7] *See id.* at Tables 12, 14.

[8] Ji, Z.-G., W.R. Johnson, and Z. Li. Draft, Jan. 2012. Oil spill risk analysis: Gulf of Mexico Outer Continental Shelf (OCS) lease sales, 2012-2017, and Gulfwide OCS Program, 2012-2051. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Division of Environmental Sciences, Herndon, VA.

[9] *Id.* Table 1b.

[10] Multisale DEIS at 3-66.

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thorough analysis of the probability of that event occurring.[11] BOEM has not done such an analysis, and accordingly it has no basis to ignore the statistics generated by its own experts regarding that event.

Moreover, BOEM's prior analysis for the 2007-2012 Multisale FEIS *did* include a ≥ 10,000 bbl spill size group,[12] even though only *two* spills within that size category occurred within the relevant timeframe (i.e., 1985-1999).[13]

3. The DEIS used median spill size as the key descriptive statistic even though the studies it relied on also reported the mean spill size.

BOEM's misleading presentation of spill data is compounded by its decision to include only a median spill size, rather than both a median and a mean spill size, for each spill size category. Even if BOEM were to retain the categories as they appear in the Multisale DEIS, including a mean spill size would better reflect the magnitude of the Deepwater Horizon spill for the public. The report that BOEM relies on includes data about mean spill sizes,[14] so BOEM could easily include it.

* * *

The Multisale Final EIS must correct the fatal flaws described above and take a hard look at oil spill risks.

B. The DEIS Underestimates the Risks of Accidental Oil Spills.

The Multisale DEIS underestimates the risk of accidental oil spills in two ways:

- BOEM's analytical framework for measuring spill risk fails to consider important variables, including water depth and well conditions; and

[11] Obviously, any such analysis must be transparent and available to the public for review and comment.

[12] *See* U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Oil and Lease Sales: 2007-2012: Final Environmental Impact Statement, at II:118 (Table 4-16).

[13] *See also* Anderson, C.M., and R.P. LaBelle. 2000. "Update of Comparative Occurrence Rates for Offshore Oil Spills." *Spill Science and Technology Bulletin*, **6**: 303-321. Table 6.

[14] U.S. Dept. of the Interior. Bureau of Ocean Energy Management. 2012. Update of oil spill occurrence rates for offshore oil spills: Draft report. 14 Jan. 2012. Table14.

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- BOEM's framework relies solely on historical spill rates (and medians) to predict the likelihood of future spills.

Both problems lead to an underestimation, and a biased discussion, of the risk of spills and of the environmental impacts such spills would have. BOEM must fundamentally change the way it calculates spill risk and take into account the key variables that affect the risk of spills.

1. BOEM's analytical framework for measuring spill risk fails to consider important variables, including water depth and well conditions.

The DEIS fails to consider important variables that affect spill risk. The oil spill risk analytical framework considers historical spill rates classified by spill size.[15] Within each spill size category, the analysis pools historical oil spill and production data across all other variables, including drilling depth, to calculate a ratio for the number of oil spills per barrel of oil produced. This ratio is then multiplied by the total volume of oil projected to be produced under the proposed action to calculate a projected number of spills.

But grouping historical data by spill size only, and not by other variables, falsely assumes that oil production across all water depths, environments, well types and other factors has an equal spill risk. In reality, deepwater and ultra-deepwater wells pose significantly greater risks than shallow wells. Appendix A to these comments – drawn from our previously submitted comments on the Programmatic EIS for the 5-Year Program – describes in detail the greater inherent risks of deepwater operations; these risks are also described by impartial sources such as the National Commission on the BP Deepwater Horizon Oil Spill ("National Commission") and the National Academy of Engineering ("NAE") and National Research Council ("NRC").[16] BOEM's own data also shows that Losses of Well Control ("LWC") have occurred more frequently in deepwater drilling than across all other water depths since 2006 (see Section IV.A.1, below, for additional discussion).[17]

[15] *See, e.g., id.*.

[16] *See, e.g.*, "Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling." National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President.* 11 Jan. 2011. Pages ix, 51-52, 73, 90-91; National Academy of Engineering, National Research Council. *Macondo Well – Deepwater Horizon Blowout: Lessons for Improving Offshore Drilling Safety* 14 Dec. 2011. Pages 1, 7, 77, 83.

[17] Izon, David. Discussion of losses of well control on the U.S. Outer Continental Shelf. Presentation to the Offshore Energy Safety Advisory Committee. 8 Nov. 2011. Washington, D.C.

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BOEM's failure to consider this key variable is particularly egregious in the Multisale DEIS because much of the area to be leased in the WPA and CPA is in deepwater.[18] To improve its spill risk analysis, at the very least BOEM must incorporate in the Multisale Final EIS the increased risk of spills at deeper water depths. This could be done by dividing exploration and production activities by water depth and then estimating the number of spills from those activities with historical spill frequency data from different water depth classes, i.e. deepwater versus non-deepwater.

2. BOEM's analytical framework for measuring spill risk is fatally flawed because it relies entirely on historical data.

Even if it were to consider important variables, BOEM's current – and longstanding – spill risk analysis framework will always be an understatement of risk[19] because it relies entirely on historical spill data. That framework cannot predict first-of-a-kind events, and is patently insufficient to assess the risks of an industry that is rapidly evolving, continuously deploying new technologies, and constantly pushing into riskier and more poorly understood environments.[20] BOEM's existing methodology has no way to account for future changes in various factors that affect drilling risk, including technology, water depth and regulations. The shift to deepwater drilling was one such change that BOEM failed to account for, as evidenced by the unexpected magnitude of the Deepwater Horizon disaster.[21] The advent and spread of floating production, storage and offloading units ("FPSOs") are another major change in offshore drilling that may alter the future risk of spills, but BOEM's analytical framework offers no way to assess and incorporate the risks associated with FPSOs. Given the irreversible and devastating consequences of an offshore spill, this historical framework for spill risk analysis is inappropriate.

The inadequacy of BOEM's analytical framework is not speculative. Precisely the same framework was used prior to the Deepwater Horizon event, and utterly failed to predict, or even consider, a spill of the magnitude that occurred. The Gulf of Mexico 2007-2012 Multisale FEIS estimated that the total volume of oil that would be spilled in the CPA as a result of the five proposed lease sales would be 5,500-26,500 bbl, whereas the Deepwater Horizon alone spilled

[18] Multisale DEIS at Tables-13 to -14 (Tables 3-2 and 3-3).

[19] Barring new technologies that effectively improve safety.

[20] *See* National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President.* 11 Jan. 2011. Page 73.

[21] *See id.*

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approximately 4.9 million bbl of oil. The National Marine Fisheries Service, in its response to BOEM's request for the reinitiation of formal consultation under the Endangered Species Act, stressed the need for a new kind of modeling:

> We recommend that revised spill probabilities and modeling of different sized spills, including catastrophic spills for the Gulf of Mexico for sources of spills in offshore and nearshore environments be conducted. These models must include both surface and deepwater sources...[22]

C. The DEIS' Analysis Misstates the Total Potential Volume of Oil Spilled Offshore.

The DEIS misstates the total potential volume of oil that would be spilled offshore, failing to inform the public and decision-makers of the true environmental impact of the proposed action. In the Multisale DEIS, BOEM estimates the total volume of oil that would be spilled as a result of the proposed action.[23] How these values are calculated is not explained in the Multisale DEIS, nor is it clear how BOEM could predict those values based on the data cited elsewhere in the document, namely the expected number of spills and median size of spills for each spill size group.[24] A straightforward analysis would calculate the total volume of oil that would be spilled by multiplying the estimated number of spills by the estimated spill sizes and then summing the resultant figures across all spill size groups. But this approach yields estimates far larger than the DEIS estimates.

For instance, over the lifetime of the proposed action in the CPA, BOEM estimates 0.52 spills of ≥ 1,000 bbl would occur[25] and the median size of those spills would be 2,200 bbl.[26] The product of these two values (0.52 spills and 2,200 bbl/spill) yields an expected spill volume of 1,144 bbl, in that one size class. But BOEM estimates the *total* volume of oil spilled in the CPA across *all* spill size groups could be as low as 900 bbl,[27] 244 bbl less than that calculated just for spills in *one* size group. In the Multisale Final EIS, BOEM must clarify how it calculates its

[22] National Marine Fisheries Service. 24 Sept. 2010. Response to BOEM's request for reinitiation of Endangered Species Act consultations, dated July 30, 2010. Page 2.

[23] Multisale DEIS at 3-66.

[24] *Id.* at 3-59, Tables-22 (Table 3-12).

[25] *Id.* at 3-59.

[26] *Id.* at Tables-22 (Table 3-12).

[27] *Id.* at 3-66.

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estimated total volume of spilled oil, explain why its approach is rational, and if its approach differs from the approach described here, contrast the values its approach yields with the values that would be yielded from the simple analysis described here.

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II. THE ANALYSIS OF THE IMPACTS OF AN OIL SPILL (THE "MASS BALANCE" ANALYSIS) FAILS TO TAKE A HARD LOOK AT THE IMPACTS OF THE MOST SERIOUS TYPES OF SPILLS.

The DEIS undercuts its analysis of potential impacts from oil spills by projecting the mass balance of only one hypothetical type of oil spill, thus failing to take a hard look at the impacts of the most serious types of spills. The Multisale DEIS provides a mass balance – which estimates the fate of each barrel of oil in a hypothetical spill over time (e.g., how many barrels are removed via skimming or broken down via natural weathering) – for only one hypothetical type of spill.[28] The hypothetical spill that BOEM models consists of 4,600 barrels spilled over 12 hours from an OCS pipeline break during the winter in the WPA. The DEIS must including additional hypothetical mass balances to give the public and decision-makers an adequate understanding of the potential consequences of oil spills.

The proposed action could lead to much larger spills, occurring under markedly different conditions, than the one hypothetical spill considered in the DEIS. For instance, the mass balance evaluated in the Multisale DEIS assumes that 100% of the spilled oil would, at one point, occur in a surface slick.[29] In deepwater subsea blowouts like the Deepwater Horizon disaster, however, large subsea plumes can form that do not appear on the surface.[30] The mass balance in the Multisale DEIS also assumes that 100% of the spilled oil would be weathered or cleaned up shortly after the spill occurs (specifically, within 48 hours). This assumption is not likely to be true in the case of catastrophic spills and spills from deepwater subsea blowouts. In the former case, oil can persist in the environment for long periods by becoming entrained in sediments and marshes[31] or forming tar mats.[32] In the latter case, oil can persist for long periods in deepwater

[28] Multisale DEIS Table 3-23.

[29] *See* Table 3-23.

[30] Reddy, C.M., et al. . Composition and fate of gas and oil released to the water column during the *Deepwater Horizon* oil spill. *Proc. Natl. Acad. Sci* Early Edition. July 2011.

[31] Whitehead, A., et al. Genomic and physiological footprint of the *Deepwater Horizon* oil spill on resident marsh fishes. *Proc. Natl. Acad. Sci.* Early Edition. Sept. 2011.

[32] Clement, T.P., J.S. Hayworth, and V. Mulabagal. Research brief: Is submerged Deepwater Horizon oil degrading offshore? *Auburn University*. 20 Sept. 2011.

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subsea plumes[33] or by settling to the seabed.[34] The single mass balance scenario in the Multisale DEIS does not fairly reflect the fate of oil in a spill comparable to the Deepwater Horizon spill, nor does it encompass the wide variety of spill sizes and conditions that can be expected to result from the proposed action.

The inadequacy of the mass balance analysis in the Multisale DEIS is highlighted by the fact that it contains even *less* information than comparable analyses conducted prior to the Deepwater Horizon event. Rather than using the lessons learned from the Deepwater Horizon disaster to improve its hypothetical mass balance scenarios by portraying various hypothetical spills, the Multisale DEIS actually *deletes* information contained in the previous 2007-2012 Multisale FEIS.[35] The 2007-2012 Multisale FEIS estimates the mass balance of hypothetical spills of 4,600 barrels for both the WPA and CPA, whereas this Multisale DEIS only estimates one for the WPA. There is no analysis of the fate of *any* oil spill in the CPA, the location of the Deepwater Horizon catastrophe and consequently the location for which, it might be expected, the most information is available about the fates of spilled oil. Moreover, BOEM's mass balance for a spill in the WPA is *exactly the same* as that in the 2007-2012 Multisale FEIS, as if BOEM had learned nothing new about spill fates as a result of the recent disaster.

To rectify these problems and comply with NEPA, BOEM must conduct and present in the Multisale Final EIS mass balances for multiple hypothetical spill scenarios, varying the season, water depth, distance to shore, spill volume and other factors that may affect the fate of oil from a spill. The analysis should include mass balances for spills from wellheads (as opposed to pipelines) and for a catastrophic spill from a well in deepwater in both the Western and Central Planning Areas.

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III. THE ANALYSIS OF IMPACTS ON THREATENED AND ENDANGERED SPECIES FAILS TO TAKE A HARD LOOK AT THE CONSEQUENCES OF UNLAWFULLY FAILING TO ENGAGE IN FORMAL CONSULTATION.

The Multisale DEIS fails to take a hard look at the consequences of unlawfully refusing to engage in formal consultation under the Endangered Species Act. It appears that BOEM has neither initiated, nor intends to initiate, formal consultation for the proposed action. Instead, the

[33] Reddy, C.M., et al. Composition and fate of gas and oil released to the water column during the *Deepwater Horizon* oil spill. *Proc. Natl. Acad. Sci* Early Edition. July 2011.

[34] McEdwards, Colleen. "Gulf seabed one year after BP disaster." *CNN.com*. 1 Sept. 2011. http://business.blogs.cnn.com/2011/09/01/gulf-seabed-one-year-after-bp-disaster/

[35] *See* U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Oil and Lease Sales: 2007-2012: Final Environmental Impact Statement, at II:137-38 (Tables 4-36 & 4-37)..

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DEIS suggests that BOEM will rely on reinitiated consultations currently underway for a prior series of lease sales in the Gulf, and on "an interim coordination and review process."[36] Neither of these approaches fulfills BOEM's duty to consult on this new series of lease sales. The Multisale Final EIS must take a hard look at impacts on protected species and in so doing fully disclose whether the proposed action's impacts will satisfy the jeopardy standard of the Endangered Species Act and whether the proposed action will even be lawful under the Act.

Section 7(a)(2) of the Endangered Species Act requires federal agencies to insure that any action they authorize or carry out "is not likely to jeopardize the continued existence" of a listed species by consulting with expert agencies – the Fisheries Service and the Fish and Wildlife Service.[37] Agencies contemplating an action must determine whether that action "may affect listed species or critical habitat."[38] If so, "formal consultation is *required*,"[39] and must be completed before beginning the planned action. The agency may determine that formal consultation is not required only if it concludes, following informal consultation and with the written concurrence of the expert agency, that "the proposed action is not likely to adversely affect any listed species or critical habitat."[40]

The Multisale DEIS concerns a new five-year program for Gulf of Mexico lease sales over the period 2012-2017. This program has not yet been the subject of a completed formal or informal consultation, nor does BOEM indicate it intends to consult. This failure to consult is contrary to the Services' guidance, which states that "[f]ormal consultation should be initiated *prior to or at the time of* release of the DEIS" for the agency action.[41] BOEM's actions are also contrary to prior agency practice. BOEM conducted both formal and informal consultations for five-year oil and gas plans for the Gulf of Mexico at the Multisale DEIS stage, both for the immediately preceding (2007-2012) Gulf Multisale, and for the 2003-2007 Gulf Multisale.[42]

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[36] Multisale DEIS at 4-975.

[37] 16 U.S.C. § 1536(a)(2).

[38] 50 C.F.R. § 402.14(a).

[39] *Id.* (emphasis added).

[40] *Id.* § 402.14(b)(1) (emphasis added).

[41] U.S. Fish & Wildlife Service, Consultations: Frequently Asked Questions, http://www.fws.gov/endangered/what-we-do/faq.html#10 (accessed February 9, 2012).

[42] *See* National Marine Fisheries Service, Endangered Species Act – Section 7 Consultation & Biological Opinion, Gulf of Mexico Oil and Gas Activities: Five-Year Leasing Plan for Western and Central Planning Areas 2007-2012. June 29, 2007. Page 2.

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BOEM's failure to consult at this stage is particularly troubling because the Multisale Final EIS will serve as the *only* environmental review for the first two lease sales in the Gulf under the 2012-2017 plan and will be followed promptly by a decision on whether those sales will be conducted.[43] BOEM cannot make that decision, or conduct those sales, without completing the consultation process.

Instead, BOEM suggests repeatedly in the Multisale DEIS that it believes it can fulfill its consultation obligations by continuing with the reinitiated consultation on the 2007-2012 Gulf Multisale.[44] BOEM is incorrect. The 2007-2012 Gulf Multisale is a *separate* project from the current (2012-2017) Gulf Multisale. The 2007-2012 Gulf Multisale encompassed entirely different lease sales over an entirely different time frame. The consultation documents produced from that prior, *separate* consultation process state explicitly that they apply only to the schedule of lease sales discussed in the 2007-2012 Multisale EIS.[45] BOEM cannot rely on the consultation process for a separate project to meet its obligations for the current proposal.

BOEM additionally notes that "[a]s BOEM moves forward with the new 5-Year Program (2012-2017), BOEM and BSEE propose to implement an interim coordination and review process with NMFS and FWS for specific activities leading up to or resulting from upcoming proposed lease sales."[46] But BOEM cannot rely on an "interim coordination and review process" to take the place of formal consultation. "Formal consultation is excused *only* where (1) an agency determines that its action is unlikely to adversely affect the protected species or habitat, *and* (2) the relevant service (FWS or NMFS) *concurs* with that determination."[47]

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[43] Multisale DEIS at vii.

[44] *See, e.g., id.* at, 4-780, 4-823, 4-975, 5-7.

[45] *See* National Marine Fisheries Service, Endangered Species Act – Section 7 Consultation & Biological Opinion, Gulf of Mexico Oil and Gas Activities: Five-Year Leasing Plan for Western and Central Planning Areas 2007-2012. June 29, 2007. Pages 2-3.

[46] Multisale DEIS at 5-7.

[47] *Natural Res. Def. Council v. Houston*, 146 F.3d 1118, 1126-27 (9th Cir. 1998) (emphases added) (agency violated Endangered Species Act by failing to request or complete formal consultation on project that Fisheries Service concluded would likely affect listed species, in reliance on Service's statement that formal consultation was not required because impacts to species were being addressed in another, ongoing consultation). *See Thomas v. Peterson*, 753 F.2d 754, 764 (9th Cir. 1985) (affidavits asserting agency had undertaken "study and action" on effects to listed species "do not constitute a substitute for the preparation of the biological assessment required by the ESA.")

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Citing Section 7(d) of the Endangered Species Act, BOEM also claims that, because the proposed lease sales would not result in an "irreversible or irretrievable commitment of resources," BOEM can proceed with the Multisale Final EIS and make a decision on which action it will take, "even if consultation is not complete."[48] But Section 7(d) applies only to preliminary activities "*[a]fter* initiation of consultation."[49] BOEM has provided no evidence that it has begun consultation on *this* project – the 2012-2017 sales in the Gulf of Mexico – so Section 7(d) is inapplicable at this stage. The Endangered Species Act requires BOEM to *complete* (not merely initiate) a *new* formal consultation on the 2012-2017 Gulf sales. The Multisale EIS must take a hard look at BOEM's failure to comply with the law, its consequences, and the impacts on protected species. Or in the better alternative, BOEM should opt to comply with its formal consultation obligations.

OCEANA-4

IV. THE MULTISALE DEIS DOES NOT CONSIDER A FULL SPECTRUM OF REASONABLE AND FEASIBLE ALTERNATIVES TO THE PROPOSED ACTION.

The Multisale DEIS violates NEPA by

- failing to consider two reasonable and feasible alternatives that would greatly alter the relative environmental impact and cost-benefit balance of the proposed action; and
- failing to properly analyze a true "No Action" alternative.

The discussion of alternatives "is the heart of the [EIS],"[50] and the agency's alternatives analysis is expected to include "a reasonable number of examples, covering the *full spectrum* of alternatives."[51] Only by doing so can the EIS "guarantee that agency decision-makers have before them and take into proper account all possible approaches to a particular project (including total abandonment of the project) which would alter the environmental impact and the cost-benefit balance."[52]

[48] Multisale DEIS at 4-975.

[49] 16 U.S.C. § 1536(d) (emphasis added).

[50] 40 C.F.R. § 1502.14.

[51] Council on Environmental Quality. Appendix B: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. 46 Fed. Reg. 18,026, 18,034. 23 Mar. 1981. Question 1b.

[52] *Alaska Wilderness Recreation & Tourism Ass'n v. Morrison*, 67 F.3d 723, 729 (9th Cir. 1995) (quoting *Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1228 (9th Cir. 1988)).)); *See California v. Block*, 690 F.2d 753, 767 (9th Cir. 1982).

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A. The Multisale DEIS Violates NEPA by Failing to Consider Two Reasonable and Feasible Alternatives That Would Greatly Alter the Relative Environmental Impact and Cost-Benefit Balance of the Proposed Action.

The Multisale DEIS should comply with NEPA by considering a full range of reasonable and feasible alternatives including

- no leasing in deep water; and
- a moratorium on leasing in 2012 and 2013.

Without consideration of these alternatives, decision-makers will not be informed about the relative costs and benefits of the proposed action.

1. The Multisale Final EIS should consider the alternative of no leasing in deep water.

BOEM preliminarily considered, but irrationally rejected for analysis, an alternative to limit leasing to shallow waters for some or all of the lease sales it proposes to hold. This alternative is reasonable because it is "practical or feasible from the technical and economic standpoint and using common sense."[53] Given the increased risks of deepwater drilling (discussed below), an alternative that excludes deepwater leasing has the potential to better protect the environment, leading to a reduced environmental impact and a more favorable cost-benefit balance than the proposed action, while still allowing development of oil and gas to continue on non-deepwater and existing leases. Moreover, alternative sources of energy to oil and gas could offset any future decreases in production from the exclusion of deepwater leasing.

BOEM irrationally claims that considering the no deepwater leases alternative is not necessary because it contends that deepwater drilling is not more risky than drilling in shallow water. But BOEM's argument is circular and unsound on the facts. First, the relative costs and benefits of the alternatives should be revealed as the result of a full analysis, not as an evidence-free proclamation that precludes analysis.

Second, while BOEM boldly asserts that "[t]he perception that shallow-water drilling is somehow safer is not borne out by the data,"[54] the data are not there to support BOEM's claim.

[53] Council on Environmental Quality. Appendix B: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. 46 Fed. Reg. 18,026, 18,034. 23 Mar. 1981. Question 2a.

[54] Multisale DEIS at 2-5.

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Numerous expert individuals and commissions, including the National Commission[55] and the NAE and NRC,[56] have concluded that drilling operations in deepwater and other frontier areas are inherently riskier operations. According to BOEM's own data, oil spills from platforms have increased in frequency and magnitude from 1985-1999 to 1996-2010,[57] as drilling operations have shifted to deepwater.[58] Furthermore, Oceana has demonstrated at length that deepwater operations are inherently riskier, using information from BOEM's Draft Programmatic EIS for the 5-Year Plan, in submitted comments on that document.[59] We have appended the relevant section of those comments onto this document.

BOEM relies on Table 2-1 in the Multisale DEIS to justify its failure to analyze the no deepwater leases alternative, but that reliance is not rational. Table 2-1 presents Losses of Well Control ("LWCs") by water depth for 2006 to 2010, without normalizing the data by the number of wells drilled by water depth. The raw data give no information about the relative risk of deepwater versus shallow water wells. To rely on this evidence, BOEM must normalize the data and publish and interpret it in the Multisale Final EIS. Even normalized data on LWCs are not necessarily indicative of overall drilling risk, because operators are not currently required to report controlled kicks[60] and other near-miss events.[61]

[55] National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President.* 11 Jan. 2011. Pages vii, ix, 51-52, 73, 90-91, 215.

[56] National Academy of Engineering, National Research Council. *Macondo Well – Deepwater Horizon Blowout: Lessons for Improving Offshore Drilling Safety.* 14 Dec. 2011. Pages 1, 7, 69, 77, 83.

[57] *See* U.S. Dept. of the Interior. Bureau of Ocean Energy Management. 2012. Update of oil spill occurrence rates for offshore oil spills: Draft report. 14 Jan. 2012. Pg. 1. ("Spill rates for OCS Platforms doubled when comparing the most recent 15 years data (1996-2010 data) to the last 15 years data in the previous analysis... from 0.13 to 0.25 spill per Bbbl for spills ≥ 1,000 bbl; and from 0.05 to 0.13 spills per Bbbl for spills ≥ 10,000 bbl.")."

[58] *See id.* ("The most recent 15 year period [1996-2010] spans the move of oil production into deepwater with deepwater OCS oil production increasing from 20% of the total in 1996 to 81% of the total in 2010.").

[59] Oceana, Alaska's Big Village Network, Center for Biological Diversity, Center for Water Advocacy, Defenders of Wildlife, Gulf Restoration Network, Ocean Conservation Research, Southern Environmental Law Center, and Sierra Club. Comments submitted on the Draft Programmatic Environmental Impact Statement for Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017. Submitted electronically on January 9, 2012. Pages 8-10.

[60] Multisale DEIS at 3-76.

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Table 2-2, which tallies all OCS blowout incidents by water depth up to 2006, normalizes the blowout data but includes no data on blowout incidents since 2006 – a glaring oversight in light of the immense blowout incident at the Macondo well in 2010. Nor has BOEM offered a reason for failing to consider incidents more recent than 2006. BOEM must update the data to include recent incidents before relying on it. In fact, LWC data for incidents after 2006[62] is already available: the number of wells drilled per LWC in all, and greater than 1,000 foot (i.e., deepwater) water depths, is 296 and 273, respectively.[63] Thus, the data demonstrate that LWCs have occurred more frequently in deepwater since 2006. This evidence makes the exclusion of these more recent data even less excusable.

2. The Multisale Final EIS should consider a moratorium on leasing in 2012 and 2013.

The Multisale DEIS also fails to evaluate, or even consider, an alternative that would forego any lease sales in the WPA and CPA during 2012 and 2013. Delaying lease sales in the Gulf of Mexico for a few years would allow time for additional vital data on the impacts of the Deepwater Horizon spill and new offshore drilling safety measures to be gathered. This alternative offers the possibility of substantially reduced environmental impacts relative to the proposed action, and it would have minimal impact on national energy production. The alternative also differs from the current flawed No Action Alternative, which nominally resembles a delay alternative, because the costs and benefits of the two-year moratorium are more measurable than those of the nebulous No Action Alternative, allowing BOEM to make a much more informed decision. A two-year moratorium on lease sales is also a reasonable increment in the full spectrum of alternatives.[64]

An alternative that delays lease sales for a few years is eminently reasonable. There are vast gaps in our understanding of current conditions in the Gulf of Mexico. While many large

[61] Controlled kicks and other near-miss events are indicative of drilling risk, as they could have led to a blowout and oil spill if they were not controlled.

[62] Specifically, between 2006 and November 8, 2011.

[63] Izon, David. Discussion of losses of well control on the U.S. Outer Continental Shelf. Presentation to the Offshore Energy Safety Advisory Committee. 8 Nov. 2011. Washington, D.C.

[64] *See* Council on Environmental Quality. Appendix B: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. 46 Fed. Reg. 18,026, 18,034. 23 Mar. 1981. Question 1b.

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offshore oil spills have occurred and continue to occur,[65] the Deepwater Horizon spill was much larger than previous spills and occurred in deepwater. The impacts of such a large, deepwater spill are not yet well understood. Information about those impacts is vitally important to understanding both the current environmental baseline in the region and the environmental costs of undertaking activities that increase the risk of such spills. As the Multisale DEIS acknowledges, great uncertainty still exists regarding what significant adverse effects the Deepwater Horizon spill has had on resources in the Gulf of Mexico.[66] Without this information, BOEM cannot adequately evaluate current conditions or predict future outcomes from the proposed action.

The degree of ignorance, at this time, regarding the effects of the Deepwater Horizon spill is staggering-- BOEM does not suggest otherwise. For example, BOEM concludes that "there is incomplete information on impacts to sea turtle populations from the DWH event" that "may lead to reasonably foreseeable, significant adverse impacts to sea turtles from accidental events."[67] BOEM makes largely identical claims with regard to marine mammals, birds, fish, Gulf sturgeon, beach mice, diamondback terrapins and a number of plant and animal species of particular interest to the Fish and Wildlife Service.[68] It claims information is similarly unobtainable regarding effects on air quality, water quality, submerged vegetation, wetlands, coastal barrier beaches, *Sargassum* communities, pinnacle trend features, live bottom features, topographic features, soft-bottom benthic communities, and the fishing industry in the Gulf, both commercial and recreational.[69] Indeed, it seems that there is scarcely any biotic resource in the Gulf for which BOEM considers itself to have sufficient information to assess the impacts of the Deepwater Horizon spill.

[65] E.g., Shell's oil spill offshore Nigeria on December 20, 2011, Chevron's oil spill offshore Brazil on November 7, 2011, and ConocoPhillip's oil spill offshore China in June, 2011.

[66] *See, e.g.*, Multisale DEIS at 2-24 ("For example, there is incomplete information on impacts to sea turtle populations from the DWH event."); *id.* at 2-27 ("Although many potential effects of the DWH event on fish populations of the GOM have been alleged, the actual effects are at this time unknown and the total impacts are likely to be unknown for several years.")".

[67] *Id.* at 2-24.

[68] *See id.* at 4-193, 4-213, 4-700 (marine mammals); 4-283, 4-296, 4-789 (birds); 2-27 (fish); 4-823 (Gulf sturgeon); 4-767 (beach mice); 2-25, 4-251 (diamondback terrapins); 4-431 (plants and animals of interest to the Fish & Wildlife Service).

[69] *See id.* at 4-439 (air quality); 4-454, 4-466 (water quality); 4-80, 4-529 (submerged vegetation); 4-503 (wetlands); 4-483 (coastal barrier beaches); 4-619 (*Sargassum* communities); 4-537, 4-558 (pinnacle trend features); 4-584 (live bottom features); 4-595 (topographic features); 4-668 (soft-bottom benthic communities); 4-860 (commercial fishing); 4-872 (recreational fishing).

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BOEM suggests that it has no obligation to obtain this missing information before proceeding, because "[r]elevant data on the status of and impacts to sea turtle populations from the DWH event may take years to acquire and analyze, and impacts from the DWH event may be difficult or impossible to discern from other factors."[70] BOEM makes similar arguments for all the other resources for which it lacks sufficient information. This logic is backwards. A lack of sufficient information about current environmental conditions, or about potential impacts from proposed action, does not authorize BOEM to give up on trying to obtain such information, or excuse BOEM from its duty under NEPA to provide a "full and fair discussion" of environmental impacts.[71] Rather, insufficient information calls for data collection, and for precautionary measures while that data is obtained. NEPA was not intended to permit agencies to proceed blindly where they do not know the environmental consequences of their actions. [72]

The fact, which BOEM has argued elsewhere,[73] that the Secretary of the Interior can delay or cancel any lease sale in the future, for any reason, does not preclude the need to consider the alternative proposed here. The point of an EIS is to analyze potential environmental and economic impacts of a proposed action and its reasonable alternatives. Here, delaying Gulf of Mexico lease sales is a reasonable alternative, and BOEM is obligated to analyze its environmental impacts. BOEM's ability to cancel scheduled lease sales does not obviate, and indeed is completely irrelevant to, its duty to conduct this environmental analysis. And while BOEM could analyze the impacts of cancelling individual lease sales in subsequent EISs at the lease sale stage, that in no way negates BOEM's duty to analyze, in *this* EIS and at *this* stage, the environmental impacts of a programmatic alternative in which Gulf of Mexico lease sales are not scheduled at all in 2012 and 2013.

[70] *Id.* at 2-24.

[71] 40 C.F.R. §§ 1502.1, 1502.22.

[72] *See, e.g., Roosevelt Campobello Int'l Park Comm'n v. EPA*, 684 F.2d 1041, 1051-1055 (1st Cir. 1982) (overturning permit issuance by EPA until simulation studies to address risk of major oil spill "have been conducted, circulated, and discussed"); *Conservation Law Found. v. Watt*, 560 F. Supp. 561, 572-573 (D. Mass. 1983) (where final EIS for offshore lease sales issued while studies of effects on endangered species were ongoing, agency "did not do 'all that was *practicable* prior to approving a project with such potentially grave environmental costs.'" (quoting *Roosevelt Campobello*, 684 F.2d at 1055)).

[73] *See, e.g.*, U.S. Department of the Interior. Bureau of Ocean Energy Management. 2011. *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017 Draft Programmatic Environmental Impact Statement.* Pages 2-10.

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B. The Multisale Final EIS Must Consider a True No Action Alternative.

The Multisale DEIS includes a purported "No Action" alternative for each of the proposed actions: an alternative in which one proposed lease sale (out of five) in the WPA would not be held for a specified period of time, and an alternative in which one proposed lease sale (out of five) in the CPA would not be held for a specified period of time. This alternative fails to satisfy the NEPA requirement for a No Action Alternative because it simply does not consider not taking the entire proposed action. The Multisale FEIS must consider an adequate No Action Alternative in which no leases would be sold in the Gulf of Mexico during the 2012-2017 period.

NEPA requires that the No Action Alternative consider a case in which "the proposed activity would not take place."[74] The current so-called No Action Alternative fails this test, as it describes a scenario in which only *part* of the proposed action would not take place. BOEM's discussion centers on cancelling *one* lease sale in each planning area, even though the proposed action anticipates *five* lease sales in each planning area. Because this purported "no action" alternative includes cancelling only one-fifth of the project, it cannot capture the environmental benefits of taking no action. In any case, BOEM's analysis of the purported "No Action" alternatives is fundamentally flawed. The Multisale DEIS states that the No Action Alternative for the WPA "would not significantly change the environmental impacts of overall OCS activity" because "the... development of oil and gas would most likely be postponed to a future sale... so the overall level of OCS activity in the WPA would only be reduced by a small percentage, if any."[75] A similar rationale is given for the No Action Alternative in the CPA.[76] On this logic, BOEM concludes that the No Action alternatives do not have notably greater environmental benefits than the proposed action.

There are two fundamental flaws in this analysis. First, BOEM disregards the importance of timing in determining the magnitude of an environmental impact. According to BOEM's reasoning, the ultimate effect of an impact from offshore drilling will be the same regardless of when that impact occurs. That is not plausible; simultaneous impacts may have a greater effect than consecutive impacts, and consecutive impacts may have a greater effect than staggered impacts. BOEM cannot fairly conclude that lease sales that happen now, as part of the proposed action, and lease sales that happen in the future, will have equivalent impacts on the ecosystem. This observation is especially important given the recent Deepwater Horizon spill and its effects on the Gulf of Mexico ecosystem. The biotic resources of the Gulf suffered a recent and

[74] Council on Environmental Quality. Appendix B: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. 46 Fed. Reg. 18,026, 18,034. 23 Mar. 1981. Question 3.

[75] Multisale DEIS at 4-434.

[76] *Id.* at 4-973.

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significant blow. Further impacts to those resources while they are in this fragile state could be disastrous. In contrast, delaying additional impacts (as the No Action alternative, in BOEM's conception, contemplates) would allow the ecosystem to recover and be more resilient.

Second, by including in its analysis an assumption that identical lease sales will occur in the future, BOEM's analysis of the No Action Alternatives is not parallel with its analysis of the proposed actions. The purpose of a No Action alternative is to serve as "a benchmark, enabling decision-makers to compare the magnitude of environmental effects of the action alternatives."[77] In the Multisale DEIS, the purported No Action Alternatives do not serve as a comparative benchmark, because BOEM irrationally considers future lease sales only in connection with the No Action Alternatives, not the proposed actions. Selectively including future events, as BOEM does here, leads to a skewed analysis.

In addition to the inadequate No Action Alternatives described above, the Multisale DEIS also makes fleeting mention of an analysis, contained in Appendix G to the Multisale DEIS, that considers a "programmatic" option of cancelling the 2012-2017 Five-Year Program in the Gulf of Mexico. But Appendix G does not compensate for the deficient no-action analyses discussed above. First, Appendix G is not incorporated into the alternatives analysis in the NEPA document itself and is mentioned only twice in the entire 2,078-page Multisale DEIS. Second, in the appendix BOEM appears to conflate a No Action Alternative of holding no lease sales in the *Gulf* during 2012-2017 with an alternative of holding no lease sales on the OCS *at all* during that period (i.e., cancellation of the entire 2012-2017 Five-Year Plan for the OCS). BOEM states that "[t]he cancellation of all lease sales of a 5-Year Program in the GOM" was "called 'Alternative 8-No Action'" in the Draft Programmatic EIS for the 5-Year OCS Program,[78] but "Alternative 8" considered cancellation of *all* lease sales in *all* OCS areas, including the Arctic. Oceana submitted extensive comments critiquing the analysis of Alternative 8, which we have submitted with this document, and contend that they are in large part equally applicable to Appendix G.

As the prior discussion shows, neither the purported "No Action" alternatives in the text of the Multisale DEIS, nor the material contained in Appendix G, are true No Action Alternatives. BOEM must include in the body of the Multisale Final EIS an actual No Action Alternative that proposes the cancellation of all ten proposed lease sales in the Gulf of Mexico and analyzes both the environmental benefits and costs of that action relative to the proposed action.

[77] Council on Environmental Quality. Appendix B: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. 46 Fed. Reg. 18,026, 18,034. 23 Mar. 1981. Question 3.

[78] Multisale DEIS at G-3.

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V. THE DEIS MISHANDLES INCOMPLETE AND MISSING INFORMATION.

BOEM's handling of incomplete and missing information in the Multisale DEIS is flawed because BOEM

- erroneously claims incomplete information is not essential; and
- fails to provide details on the "scientific methods and approaches" it uses.

Throughout the Multisale DEIS, BOEM claims that data on the impacts of the Deepwater Horizon disaster, even if essential to a reasoned choice among alternatives,[79] will not be available within a timeframe relevant to the Multisale EIS. For example, with regard to sea turtles, BOEM states:

> [T]here is incomplete or unavailable information that may lead to reasonably foreseeable, significant adverse impacts to sea turtles from accidental events. For example, there is incomplete information on impacts to sea turtle populations from the DWH [Deepwater Horizon] event. Relevant data on the status of and impacts to sea turtle populations from the DWH event may take years to acquire and analyze... *Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated in this EIS*, regardless of the cost or resources needed.[80]

As noted in Section IV above, BOEM makes similar claims of unobtainable information with respect to virtually every significant biotic resource in the Gulf.

In light of the immense array of information that BOEM claims it cannot obtain at this time, BOEM cannot adequately assess the existing baseline in the Gulf. Proceeding with the proposed action without established baseline values for nearly every important aspect of the Gulf ecosystem would be extremely unwise. BOEM simply cannot predict or evaluate the effects of the proposed action without at least a rough idea of the ecosystem's "starting values" – a point that BOEM acknowledges when it concludes that the unavailable information for many resources may well be *essential* to making a reasoned choice between the proposed action and other alternatives.[81] Going forward with the EIS process in the face of so many unknowns is a clear violation of the spirit of NEPA, the goal of which is to "ensure[] that the agency *will not act* on incomplete information, only to regret its decision after it is too late to correct."[82] Under these

[79] *See* 40 C.F.R. § 1502.22.

[80] Multisale DEIS at 2-24 (emphasis added).

[81] *Id.* at 4-438.

[82] *Marsh v. Oregon Natural Resources Council*, 490 U.S. 360, 371 (1989) (emphasis added).

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circumstances, the Multisale DEIS does not serve its purpose and is a comprehensively inadequate environmental assessment document.

A. BOEM Erroneously Claims that Incomplete Information is Not Essential to a Reasoned Choice in Violation of NEPA.

Council on Environmental Quality ("CEQ") regulations set forth how agencies are to deal with incomplete and unavailable information:

> If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.[83]

At multiple points in the Multisale DEIS, BOEM claims that incomplete information regarding the impacts of the Deepwater Horizon disaster on various biotic resources, as well as the local community, is not essential to a reasoned choice between the proposed action and other alternatives.[84] This conclusion purports to excuse BOEM from the obligation to obtain that information. However, BOEM is not correct in concluding that the information it cites is not essential to its decision-making process. Information regarding the impacts of the Deepwater Horizon disaster on these Gulf resources is essential to understanding current baseline conditions in the Gulf in the wake of a catastrophic spill, and is essential to any "full and fair discussion" of potential impacts of future spills. BOEM cannot avoid its obligation to obtain unavailable information simply by declaring that essential information is nonessential.

BOEM does not offer appropriate reasons for concluding that this information is not essential. In some cases, BOEM states that incomplete information is not essential to a reasoned choice among alternatives because "activities that could result in an accidental spill in the WPA would be ongoing whether or not a WPA proposed action occurred."[85] This line of reasoning is

[83] 40 C.F.R. § 1502.22(a).

[84] BOEM makes this claim in the Multisale DEIS with regard to marine mammals (4-213), birds (4-296), fish and essential fish habitat (4-296), beach mice (4-768), diamondback terrapins (4-251) and a number of plant and animal species of particular interest to FWS (4-431), as well as effects on air quality (4-439), water quality (4-454, 4-466), submerged vegetation (4-81), wetlands (4-503), coastal barrier beaches (4-483), *Sargassum* communities (4-619), topographic features (4-90) soft-bottom benthic communities (4-668), archaeological resources (4-354) and the fishing industry in the Gulf, both commercial (4-330) and recreational (4-872).

[85] Multisale DEIS at 4-241 (regarding impacts on sea turtles); 4-254 (regarding diamondback terrapins). Similar language is used for birds (4-296) and marine mammals (4-214) in the WPA, and identical claims are made for the CPA.

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seriously flawed. Ongoing activities in the WPA are the cumulative result of many decisions exactly like the one considered in the Multisale EIS, i.e. whether to allow leasing and drilling in the Gulf of Mexico. To make a decision in the Multisale EIS based on these ongoing activities would amount to an offshore drilling positive feedback loop: permitted activities justify the proposed activities, so the proposed activities are approved, which perpetuate the permitted activities, which are used to justify future proposed activities. Such an approach is inconsistent with NEPA and must not be adopted by BOEM. Moreover, such an approach ignores the possibility that the proposed action, if approved, could have an additive or cumulative effect on these resources, in excess of the effects of ongoing activities; indeed, the likelihood of such an additive or cumulative effect is demonstrated by BOEM's spill risk analysis. These cumulative effects could be significant enough to change the environmental cost-benefit analysis for the proposed action. Consequently, BOEM cannot dismiss the need for incomplete information solely on the basis that similar activities are ongoing.

Elsewhere, BOEM states that:

> [T]his information [on the impacts of the Deepwater Horizon spill] is not essential to a reasoned choice among alternatives. *The likely size of an accidental event resulting from a CPA proposed action would be small* and unlikely to impact coastal and estuarine habitats where juvenile and larval stages of fish resources are predominant, and adult fish tend to avoid adverse water conditions.[86]

Again, this rationale is not a valid basis to conclude that information is not essential. BOEM is saying, in essence, that information about the impacts of the Deepwater Horizon is not essential because a large spill (like the Deepwater Horizon spill) is not likely to occur. But this is simply not accurate. While it is true that accidental spills resulting from a CPA proposed action are more likely to be small than large, it is *not* true that the likelihood of a large or catastrophic spill is also small. This is due in part to the broad nature of the proposal itself. Indeed, Ji et al. in their updated model calculate that the probability of a ≥ 10,000 bbl spill occurring in the CPA as a result of the proposed action is as high as 24% – hardly a trivial likelihood.[87] BOEM cannot ignore the reasonable possibility that a large or catastrophic spill may well occur as a result of the proposed action; since an understanding of the impacts of such a spill might well lead a decision-maker to reconsider the wisdom of proceeding with the proposed action, information on the Deepwater Horizon spill and its impacts is essential to a reasoned choice among alternatives.

[86] *Id.* at 2-61 (emphasis added). *See also id.* at 4-354 (. discussion of impacts on archaeological resources).

[87] Ji, Z.-G., W.R. Johnson, and Z. Li. Draft, Jan. 2012. Oil spill risk analysis: Gulf of Mexico Outer Continental Shelf (OCS) lease sales, 2012-2017, and Gulfwide OCS Program, 2012-2051. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Division of Environmental Sciences, Herndon, VA. Table 1b.

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B. BOEM Must Provide a Detailed Explanation of its "Accepted Scientific Methods and Approaches" to Comply with NEPA.

BOEM must make publicly available a detailed explanation of the "accepted scientific methods and approaches" it has used in drafting the Multisale DEIS. BOEM repeatedly states that, in lieu of obtaining information it deems to be incomplete or unavailable, "BOEM subject-matter experts have used available scientifically credible evidence in this analysis, applied using accepted scientific methods and approaches." Similar language has been used in past EISs as well.[88] At no point has BOEM detailed what these "accepted scientific methods and approaches" are, nor has it appeared to make such information publicly available. Such information is crucial for public involvement in the decision-making process for offshore drilling in the Gulf. That is particularly true in light of the ongoing Natural Resources Damage Assessment ("NRDA") process, which has made publicly unavailable a great deal of information regarding the impacts of the Deepwater Horizon spill. Furthermore, CEQ has stated that an EIS "must explain or summarize methodologies of research and modeling" – a clear mandate that information on the "accepted scientific methods and approaches" be provided by BOEM.[89] BOEM should append the requested information to the Multisale Final EIS.

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VI. THE DEIS FAILS TO TAKE A HARD LOOK AT THE SHORT- AND LONG-TERM TRADEOFFS INVOLVED IN THE PROPOSED ACTION, INCLUDING THE IMPACTS OF GREENHOUSE GAS EMISSIONS.

NEPA requires EISs to contain "a detailed statement... on the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity..."[90] The Multisale DEIS does not include climate change or ocean acidification in its discussion of that relationship. The proposed action would exacerbate climate change and ocean acidification through greenhouse gas emissions. Yet the Multisale DEIS fails to take a hard look at the short- and long-term tradeoffs involved in these emissions. Specifically, the Multisale EIS should take a hard look at

[88] E.g., Bureau of Ocean Energy Management, Regulation and Enforcement. Final Supplemental Environmental Impact Statement for Gulf of Mexico OCS Oil and Gas Lease Sale: 2011, Western Planning Area 218. Page 4-10.

[89] Council on Environmental Quality. Appendix B: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. 46 Fed. Reg. 18,026, 18,034. 23 Mar. 1981. Question 25a. *See Lands Council v. Vaught*, 198 F. Supp. 2d 1211, 1238 (E.D. Wash. 2002) ("For an environmental impact statement to contain high quality information, it must include a description of the methodologies it relies upon.")

[90] 42 U.S.C. § 4223(C)(iv).

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- greenhouse gas emissions from upstream and downstream operations resulting from the proposed action; and
- greenhouse gas emissions from the combustion of oil and gas produced by the proposed action.

Climate change and ocean acidification will play major roles in shaping the long-term productivity of the United States' coastal regions, including the Gulf of Mexico offshore and shoreline environments.[91] A modeling study of the Northeast Atlantic showed that the impacts of ocean acidification and climate change on biogeochemical cycles and ranges of important fish species could lower their estimated potential to be caught in fisheries[92] by 20–30%.[93] An additional change in plankton communities due to ocean acidification and climate change could further reduce catch potentials of important fish species by 10%.[94] Climate change and ocean acidification also threaten the world's tropical coral reefs through the combined stresses of warming sea surface temperatures and reduced carbonate accretion. Harm to coral reefs, in turn, threatens reef-associated fisheries, tourism, coastal protection and people within the U.S. Exclusive Economic Zone offshore Gulf Coast states.[95]

While the Multisale DEIS recognizes that climate change may significantly affect the coasts and oceans of the United States, it fails to connect these and other climate change-induced threats to emissions from the combustion of oil and gas and from all routine activities, which have a cumulative impact on climate change. An EIS must "consider the cumulative impact of

[91] E.g.: Sumaila, U.R., W.W.L. Cheung, V.W.Y. Lam, D. Pauly and S. Herrick. (2011). Climate change impacts on the biophysics and economics of world fisheries. *Nature Climate Change*. Advanced Online; Turner, R.E. "Chapter 6: Coastal Ecosystems of the Gulf of Mexico and Climate Change." *Integrated Assessment of the Climate Change Impacts on the Gulf Coast Region*. June 2003; Fabry, V. J., Seibel, B. A., Feely, R. A., and Orr, J. C. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. *ICES Journal of Marine Science* **65**, 414–432.

[92] Specifically, 10-year average catch potential of 2050 relative to 2005.

[93] Cheung W. W. L., Dunne J., Sarmiento J. L. & Pauly, D. 2011. Integrating ecophysiology and plankton dynamics into projected maximum fisheries catch potential under climate change in the Northeast Atlantic. *ICES Journal of Marine Science*. doi:10.1093/icesjms/fsr012.

[94] *Id.*

[95] Hoegh-Guldberg, O. et al. 2007. Coral reefs under rapid climate change and ocean acidification. *Science* 318 (5857), 1737-1742.

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the proposed action."[96] "The impact of greenhouse gas emissions on climate change is precisely the type of cumulative impacts analysis that NEPA requires agencies to conduct."[97] As "individually minor but collectively significant actions taking place over a period of time"[98], greenhouse gas emissions qualify as cumulative impacts, and so the failure of the Multisale DEIS to account for and consider the cumulative impacts of these emissions is a violation of NEPA.

A. The Multisale DEIS Should Take a Hard Look at Greenhouse Gas Emissions from Upstream and Downstream Operations Resulting from the Proposed Action.

Routine activities, including those upstream and downstream of oil and gas production, emit significant amounts of greenhouse gases that must be quantified. Currently, the Multisale DEIS only quantifies greenhouse gases from activities on the Gulf of Mexico OCS associated with production and exploration, e.g. service vessel trips and helicopter operations.[99] However, routine activities at all stages of oil and gas production, from exploration to development to transportation to refining to decommissioning, would result from the proposed action and so fall in the scope of the Multisale DEIS.[100] Therefore, their impacts must be considered in the Multisale Final EIS. The emissions from these activities would have significant environmental impacts. Yet, the Multisale DEIS neglects greenhouse gas emissions from activities downstream of production, such as the refining of oil and gas and transportation of refined products to their point of consumption, and upstream of development, such as the construction of platforms. Given the need for the Multisale EIS to fully account for greenhouse gas emissions resulting from the proposed action as explained above, the Multisale Final EIS must quantify greenhouse gas emissions from all activities upstream and downstream of oil and gas development and production on the Gulf of Mexico OCS. To do so, BOEM could draw its system boundaries from the production of infrastructure necessary to produce oil and gas in the Gulf to the combustion of the oil and gas products.

[96] *Kern v. U.S. Bureau of Land Mgmt.*, 284 F.3d 1062, 1076 (9th Cir. 2002).

[97] *Center for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1217 (9th Cir. 2008).

[98] 40 C.F.R. § 1508.7.

[99] *See* Tables 4-2 and 4-64.

[100] 40 C.F.R. § 1508.25.

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B. The Multisale DEIS Should Take a Hard Look at the Greenhouse Gas Emissions from the Combustion of Oil and Gas Produced by the Proposed Action.

The fact that oil and gas from the Gulf of Mexico is merged with oil from other sources into a single, undifferentiated stream does not preclude the need to account for greenhouse gas emissions from the combustion of oil and gas. Climate change is a global phenomenon, and greenhouse gas emissions contribute to climate change regardless of their point of origin. Although BOEM cannot predict where OCS oil and gas will be combusted, BOEM can predict and quantify in what sector OCS oil and gas will be combusted and the consequent greenhouse gas emissions. The U.S. Energy Information Administration projects levels of consumption of oil and gas by sector to 2035.[101] From these data, BOEM can determine the proportion of oil and gas produced under the proposed lease sales that will be consumed in each sector in the future. How much of each petroleum product a barrel of crude oil yields after refining is also available.[102] Finally, greenhouse gas emissions coefficients for the combustion of oil and gas in various sectors/applications are available from the U.S. Environmental Protection Agency.[103] With the above datasets, BOEM is able to calculate the greenhouse gas emissions resulting from the proposed action in the Gulf of Mexico, and as explained above, BOEM must do so in order to satisfy NEPA.

Even if BOEM deems it too difficult to calculate greenhouse gas emissions from the combustion of oil and gas produced under the proposed action using the above datasets – a conclusion that, if made, must be thoroughly explained – BOEM is not exempt from calculating those greenhouse gas emissions. The calculation of greenhouse gas emissions from the combustion of oil and gas produced as a result of the proposed action can be greatly simplified. The emissions factors for the combustion of oil and gas, regardless of sector/application, is readily available from the U.S. Environmental Protection Agency.[104] Additionally, the Multisale

[101] Energy Information Administration. *Annual Energy Outlook 2011*. 26 Apr. 2011.

[102] "Oil (petroleum): What Fuels Are Made From Crude Oil?" *Energy Information Administration*. Accessed 23 Dec. 2011. http://www.eia.gov/kids/energy.cfm?page=oil_home-basics

[103] Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008*. 15 Apr. 2010. Annex 2, Table A-36.

[104] Crude oil emissions factor: "Green Power Equivalency Calculator Methodologies." *EPA*. Apr 2011. http://www.epa.gov/greenpower/pubs/calcmeth.htm; http://www.epa.gov/greenpower/pubs/calcmeth.htm.Natural gas emissions factor: "AP-42, Vol. 1, CH1.4: Natural Gas Combustion." *EPA*. July 1998. Page 1.4-6, Table 1.4-2. http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf.

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DEIS estimates how much oil and gas would be produced as a result of the proposed action. With these two data sets, calculating greenhouse gas emissions under the proposed action is a straightforward matter.

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VII. THE MULTISALE DEIS FAILS TO TAKE A HARD LOOK AT THE PERSISTENT SHORTCOMINGS IN THE REGULATION AND SAFETY OF OFFSHORE OIL AND GAS DRILLING.

Since the Deepwater Horizon spill, BOEM and the Bureau of Safety and Environmental Enforcement ("BSEE") have promulgated new regulations in an attempt to make offshore drilling safer. Some of these new regulations are discussed at length in Section 1.3.1 of the Multisale DEIS. We support and applaud ongoing efforts to make offshore drilling safer, but Oceana has identified numerous problems in the regulations of the offshore industry in its report *False Sense of Safety*.[105] These problems fall into two categories: shortcomings in the new safety measures implemented since the Deepwater Horizon spill; and persistent overarching problems in the regulation of offshore activities, such as insufficient inspection and oversight capabilities and inadequate penalties for violations. As a result, BOEM and BSEE have failed to make offshore drilling substantially safer since the Deepwater Horizon disaster.

The Multisale DEIS does not acknowledge any problems in the regulation of offshore oil and gas activities, despite its lengthy discussion of newly implemented regulations and their purported positive effect on offshore safety.[106] This imbalanced discussion violates NEPA guidelines as well as the Department of the Interior's new scientific integrity policy.[107]

NEPA requires an EIS to "provide full and fair discussion of environmental impacts."[108] While the new safety regulations themselves are not environmental impacts, they directly affect the impact analysis and hence affect BOEM's discussion of the new regulations. A discussion of environmental impacts that is predicated upon an imbalanced, unsubstantiated and incomplete set of factors that drive those impacts will itself be imbalanced, unsubstantiated and incomplete. Thus, it is crucial for a full and fair discussion of environmental impacts that the discussion of new regulations (and other factors influencing environmental impacts) be full and fair as well,

[105] *False Sense of Safety*, Oceana's report on persistent shortcomings in the regulation of offshore drilling, is available online at http://www.oceana.org/safetyreport.

[106] *See* Multisale DEIS at 1-7 to 1-11, 3-67 to 3-69.

[107] U.S. Department of the Interior. "Integrity of Scientific and Scholarly Activities." *Departmental Manual*. Series 5, Part 305, Chapter 3.

[108] 40 C.F.R. § 1502.1.

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which they are not. An objective analysis of the weaknesses and insufficiencies in the regulations is called for here.

The Department's new scientific integrity policy similarly demands a more balanced discussion of the new safety regulations. The policy requires science to be communicated "clearly, honestly, objectively, thoroughly, [and] accurately."[109] As previously explained, the current communication of the new safety measures, and consequently the risks and effects of oil spills and other impact factors, is not balanced or objective. This directly violates the Department's new scientific integrity policy. This Multisale EIS provides an ideal and timely opportunity for the Department to demonstrate its commitment to transparency and clarity in its scientific communications, but the Multisale DEIS has failed to meet that promise.

In order to comply with NEPA and to satisfy the Department of the Interior's scientific integrity policy, the Multisale Final EIS must present a more balanced discussion of new regulations and other safety measures implemented since the Deepwater Horizon spill. To do so, the Multisale Final EIS should discuss persistent safety concerns in offshore drilling that have not yet been addressed, as well as shortcomings in the new regulations. It also should present detailed analyses to support its claim that the new regulations and other measures have improved offshore safety.

****

The 2012-2017 Multisale DEIS for the WPA and CPA of the Gulf of Mexico suffers from serious flaws and omissions that must be addressed in the Multisale Final EIS in order to comply with NEPA and OCSLA. Based on the Multisale DEIS, it appears that BOEM has not learned from the Deepwater Horizon spill or the many decades of impacts on the Gulf of Mexico, and that the agency is continuing to prioritize oil and gas development over environmental and human protection rather than balancing these considerations as required by OCSLA. Such a path will, sooner or later, lead to another human and environmental tragedy in the Gulf.

OCEANA-8

Fortunately, the Multisale Final EIS offers BOEM an opportunity to fundamentally change course and reassess its prioritization of oil and gas development over environmental protection. In so doing, BOEM should address the omissions and flaws discussed above, adequately consider alternatives, and ultimately select an alternative that does not simply continue failed policies that have led to tragedies and massive environmental degradation in the Gulf of Mexico. Such an alternative may involve the development of alternate/renewable energy

[109] U.S. Department of the Interior. "Integrity of Scientific and Scholarly Activities." *Departmental Manual.* Series 5, Part 305, Chapter 3, Section 3.7.2.

sources. We appreciate the opportunity to submit comments on this important document, and look forward to reviewing the Multisale Final EIS.

Sincerely,

Jacqueline Savitz
Senior Scientist, Senior Campaign Director
Oceana

Deirdre McDonnell
Senior Attorney, Oceans Program
Center for Biological Diversity

Nikos Pastos
Environmental Sociologist
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Ocean Conservation Research

Jill Mastrototaro
Gulf Coast Campaign Director
Sierra Club

Catherine Wannamaker
Senior Attorney
Southern Environmental Law Center

APPENDIX A: INCREASED RISK OF DEEPWATER DRILLING[110]

BOEM, in its Draft Programmatic EIS ("Draft PEIS"),[111] lists many risk factors that affect catastrophic discharge events in Table 4.3.4-1. In addition to water depth, the listed risk factors are geology; well design and integrity; loss of well control prevention and intervention; human error; containment capability; response capability; scale and expansion; geography; and oil type, weathering and fate. As is demonstrated below, of these nine additional risk factors, the first six all correlate with water depth. In other words, the risk of a catastrophic discharge event associated with these six factors is greater in deepwater and ultra-deepwater environments. The correlation of each risk factor with water depth is discussed in turn below.

Geology varies between areas in the Gulf of Mexico, but geologic risk in general increases with increasing drilling depth (i.e., water depth) (Draft PEIS 4-68). Geologic risk also increases when drilling in "frontier areas" (id. 4-68), which includes deepwater and ultra-deepwater areas. Furthermore, deepwater reservoirs in the Gulf of Mexico have many challenging geologic characteristics, e.g. narrow margins in pore pressure and fracture gradient (id. 4-70) and high-pressure/high-temperature conditions (id. 4-70).

Well design and integrity risk also positively correlates with water depth. Geologic factors like high-pressure/high-temperature conditions and narrow margins in pore pressure and fracture gradient "represent key concerns for the potential influence geology exerts on wellbore integrity" (Draft PEIS 4-70). Thus, geologic risk positively correlates with well integrity risk; as geologic risk increases, well integrity becomes harder to maintain and so the risk of losing well integrity increases. Since geologic risk increases with water depth, so too then does well integrity risk. Indeed, the Draft PEIS states that drilling deepwater and ultra-deepwater wells challenges drilling engineers, as more casing strings are necessary, which makes it harder to achieve good cement isolation (4-73). Furthermore, water depth increases the complexity of operations (Draft PEIS 4-68, Table 4.3.4-1), and greater complexity "may present more opportunity for mechanical breakdown and accidents" (id. 4-71).

Loss of well control prevention and intervention risk, or the potential inability of an operator to prevent or intervene in the case of loss of well control, is also greater at increased

[110] This appendix is reproduced from: Oceana, Alaska's Big Village Network, Center for Biological Diversity, Center for Water Advocacy, Defenders of Wildlife, Gulf Restoration Network, Ocean Conservation Research, Southern Environmental Law Center, and Sierra Club. Comments submitted on the Draft Programmatic Environmental Impact Statement for Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017. Submitted electronically on January 9, 2012. Pages 8-10.

[111] U.S. Department of the Interior. Bureau of Ocean Energy Management. 2011. *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017 Draft Programmatic Environmental Impact Statement.*

water depths. In deepwater and ultra-deepwater environments, intervention operations after a blowout must be conducted remotely, e.g. by using a remotely operated vehicle ("ROV"; Draft PEIS 4-75). ROVs and other remote systems, though, can fail, increasing the failure risk of intervention operations. High pressure blowouts, which are generated by high-pressure reservoir conditions such as those in deepwater environments (see above), can render blowout preventers ("BOPs") not functional, thereby eliminating the last line of defense against a loss of well control. And if a blowout does occur, the need for remote operations makes subsea efforts to stop a blowout more difficult, as the Deepwater Horizon disaster demonstrated.

Human error risk also positively correlates with water depth. Water depth increases the complexity of operations (Draft PEIS 4-68, Table 4.3.4-1), and greater complexity increases the number of routine operations and incidence of unusual operations (Draft PEIS 4-71). More routine and especially unusual operations increase the risk that human error can occur.

Containment capability also varies with water depth, as well containment operations are harder to conduct in deepwater and ultra-deepwater environments, i.e. frontier areas. Containment caps have not yet been built to withstand water depths beyond 10,000 feet and pressures above 15,000 psi, so containment is not an option for ultra-deepwater operations taking place at water depths or pressures greater than these values. More importantly, containment systems like capping stacks are more difficult to install in deepwater, ultra-deepwater and other frontier areas due to inhospitable environments and the need for remote operations.

Response capability also positively correlates with water depth. The Deepwater Horizon disaster was the first deepwater blowout and revealed significant differences in response capability between blowouts in shallow and deepwater. Because of the depth of the Macondo well, a large portion of the oil and gas that escaped from the well formed subsea plumes and/or dispersed into the water column, rather than rising to the surface where it could be recovered or would aerosolize.[112] Thus, the capability to respond to the spill through oil removal was undercut because the well was located in deepwater.

As demonstrated above, six of the nine non-water depth risk factors for catastrophic discharge events positively correlate with water depth. Thus, water depth is not "just one of many risk factors" (Draft PEIS 2-12), but rather is more broadly representative of the risk of offshore drilling. Certainly water depth is not the only risk factor that should be considered in making leasing decisions. But the link between water depth and additional risk factors for catastrophic discharges demonstrates that environmental impacts will be significantly different in deepwater leasing, and underscores the need to consider an alternative in which deepwater leasing would be deferred.

[112] E.g., Reddy, C.M., et al. Composition and fate of gas and oil released to the water column during the *Deepwater Horizon* oil spill. *Proc. Natl. Acad. Sci* Early Edition. July 2011.

Oceana

Oceana-1 Comment A: (1) The primary table of interest (**Table 3-12**) has been modified in accordance with the provided recommendations. Two new lines have been added to the table to include both ≥10,000 bbl and catastrophic size categories. During the last 15 years, the only ≥10,000bbl spill was the DWH event, which is considered to be a low-probability, catastrophic event as reflected in **Table 3-12** (**Appendix B**). (2) A spill size category of ≥10,000 bbl has now been included in this **Table 3-12**. The caveat is that the only spill in this size category during the last 15 years is the DWH, which we included in the catastrophic category. (3) A note has now been added to **Table 3-12** as follows: "The average (vs. the median) spill sizes for a larger number of spill size categories can also be found in the original source." With the ≥10,000 bbl and catastrophic size categories now presented in the **Table 3-12**, hopefully the issue of whether average or median sizes are being presented is not such a concern.

Comment B: (1) The BOEM scientists and engineers are currently considering other ways of calculating the risk of oil spills in the Gulf of Mexico. Factors to be considered would likely include bottom depth, type of geological formation and difficulty of drilling in that formation, and type of drilling activity (exploration vs. production). This is an active area of inquiry, and whether there are meaningful relationships is still being explored. (2) The BOEM is actively exploring various methods for calculating oil spill-risks in the Gulf of Mexico. New modeling that was included in the Draft Multisale EIS includes the Oil Spill Risk Analysis (OSRA) catastrophic modeling (**Appendix C**). In this OSRA catastrophic analysis, 5 different points were chosen as launch points, and spills were assumed to last for a total of 90 days. The conditional probabilities show seasonal differences in contact with land after 3, 10, 30, and 120 days. The BOEM also currently has an active study to develop a next-generation, oil-spill model to better assess both surface and subsurface risks from an oil spill. (3) The text of the Draft Multisale EIS (page 3-66) states the following: "In terms of the risk to resources from offshore spills, BOEM estimates that about 200-2,600 bbl of oil would be spilled in offshore waters over the 40-year life of a WPA proposed action and about 900-3,900 bbl of oil would be spilled in offshore waters over the 40-year life of a CPA proposed action." The following line has been clarified in the Final Multisale EIS to read as follows: "These estimates are a sum of volumes from spill incidents in all size groups and are based on the range in number of spills calculated using the low and high projected oil estimates (**Table 3-1 and Table 3-12**)." For example, the low-end volume of the 900 bbl specifically referred to by the reviewer for the CPA is a sum of 22 bbl in the 0-<10 bbl category + 103 bbl in the 10-<50 bbl category + 746 bbl in the 500-<1000 bbl category. For this low-end volume (based on the low projected oil estimate), a negligible number of spills are estimated in the ≥1,000 bbl size category. However, for the high projected oil estimate, one ≥1,000 bbl spill contributes to the total high-end spill estimate of 3,900 bbl.

Oceana-2 **Table 3-23** has been removed from the Final Multisale EIS because alone it does not adequately represent the numerous spill scenarios that were run in the 2007-2012 Multisale EIS (USDOI, MMS, 2007c). In fact, this previous analysis included four different scenarios for a simulated pipeline break with variation of season, oil type, and wind conditions. The mass balance analysis in **Chapter 3** is intended to provide an analysis of the "estimated" spill sizes for a proposed action, with the bulk of the discussion on catastrophic spill events provided in **Appendices B and C**. However, we have now also included references to the DWH event to give examples of differences between an estimated spill size and catastrophic event. For example, under "Fate of Offshore Spills ≥1,000 bbl – Persistence" (page 3-60 of the Draft Multisale EIS), the following text has been added to the Final Multisale EIS: "However, longer persistence times would be appropriate for catastrophic spill events. For example, oil from the DWH spill was last observed on the surface by overflight 19 days following capping of the well (OSAT, 2010)." As well, under "Fate of Offshore Spills ≥1,000 bbl – Weathering" (page 3-61 of the Draft Multisale EIS), the following text has been added to the Final Multisale EIS: "However, other fates would likely be appropriate to a catastrophic spill event, especially in deep waters. For example, for the DWH spill, Ryerson et al. (2012a) estimated that the total hydrocarbon mass (including gas fraction) was partitioned amongst the following fates: ~36 percent to the deep subsurface plume; ~21 percent recovered by surface ships; ~10 percent to a surface slick; ~6 percent flared at the surface; and ~4 percent evaporated at the surface, which leaves ~23 percent unaccounted for based on available chemical data. Ongoing research, such as through the NRDA process, continues to evaluate the fates of DWH oil."

Oceana-3 The BOEM and BSEE are in the process of formally and informally consulting with both NMFS and FWS, similar to past Multisale EIS's. This is stated throughout the document. On February 14, 2012, NMFS and BOEM finalized an interim ESA process for project-specific consultation procedures that will remain in place until a new biological opinion is completed. The BOEM continues to work with NMFS and FWS both during the lease sale process and on postlease activity approvals to continue to meet its obligations under Section 7 of the ESA.

Oceana-4

The NEPA does require an analysis of alternatives, but it does not require a detailed analysis of all alternatives considered. With respect to the alternative of limiting leasing to shallow waters, normalized data show fewer blowouts per wells drilled in water >1,000 ft (305 m) deep than for blowouts in all water depths. Even including the data cited by Oceana regarding losses of well control since 2006, the data show that since 1992, there have been fewer losses of well control per well drilled in waters >1,000 ft (305 m) deep than for blowouts in all water depths. In addition, spills from wells in shallow water would be closer to sensitive coastal resources. These factors contributed to the conclusion that this alternative did not meet the purpose and need.

The alternatives for this Multisale EIS are those available within the framework of the 2012-2017 Five-Year Program. The No Action Alternative described for both the WPA and the CPA would result in no lease sales in the Gulf of Mexico OCS under the 2012-2017 Five-Year Program. (The scheduled CPA Lease Sale 216/222 in 2012 is not the subject of this EIS.) If the No Action Alternative is selected, the first lease sale that could occur in the Gulf under the 2012-2017 Five-Year Program would be subject to additional NEPA review, most likely a Supplemental EIS. The Programmatic No Action Alternative (no Gulf of Mexico lease sales in the next 5 years) is described in **Appendix G**. The description of the Programmatic No Action Alternative is more detailed than that of the No Action Alternative for cancellation of a single lease sale in either planning area.

Oceana comments that the timing of impacts of oil and gas activity is significant, that the Gulf must recover from the DWH event before any further impacts occur, and that BOEM should delay any sales until 2014. However, the suspension of all oil and gas activity in the Gulf OCS is not an option for this Multisale EIS, as approximately 95 percent of the wells drilled on the Gulf OCS would be on blocks already leased in prior sales. The result is that the environmental impacts of a proposed lease sale would represent an incremental increase in oil and gas activity, and selection of the No Action Alternative would not prevent or substantially reduce the probability of such impacts in the near term.

Oceana comments that the Programmatic No Action Alternative in **Appendix G** is not valid because it conflates the alternative of holding no lease sales in the Gulf OCS with an alternative of holding no lease sales on the OCS "at all" during 2012-2017. The Programmatic No Action Alternative in **Appendix G** is clearly defined as a cancellation of all "Gulf" lease sales during that period, from the title throughout the section. Alternative 8 of the *2012-2017 Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017; Draft Environmental Impact Statement* was mentioned twice, and the wording has been revised to remedy any confusion between cancellation of all "Gulf" OCS sales versus "all" OCS sales.

Oceana-5

As acknowledged in this Multisale EIS, credible scientific data regarding the potential short-term and long-term impacts of the DWH event is incomplete. In light of the absence of this information, BOEM considered what incomplete or unavailable information was relevant to the assessment of impacts and essential to its analysis of alternatives based upon the resource analyzed. If essential to a reasoned choice among the alternatives, BOEM considered whether it was possible to obtain the information, if the cost of obtaining it is exorbitant, and if it cannot be obtained in a timely fashion, applied acceptable scientific methodologies to inform the analysis in light of this incomplete or unavailable information. Conclusive information on many impacts of the DWH event and oil spill, particularly as part of the NRDA process, may not be available for years, and certainly not within the contemplated timeframe of this NEPA process. In its place, subject-matter experts have used the scientifically credible information available and accepted scientific methodologies to evaluate impacts to the resources while this information is unavailable.

In accordance with Section 1502.22 of the CEQ regulations implementing NEPA, when an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an EIS and when there is incomplete or unavailable information, the agency shall always make clear that such information is lacking. However, NEPA does not require that all informational gaps be addressed before an EIS is completed and a decision is made. In accordance with 40 CFR 1502.22, where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives, and if so, was either acquired or in the event it was impossible or exorbitant in cost to acquire the information, what scientifically credible information was available was applied using accepted scientific methodologies in its place. Language in **Chapters 4.1 and 4.2**, "Incomplete or Unavailable Information," was clarified to prevent any misperceptions on this issue, and the BOEM subject-matter experts in the individual resource analyses have identified where there is incomplete or unavailable information and explained whether it was relevant to impact analyses, could be obtained, and whether it was essential to a reasoned choice among alternatives, where appropriate.

In addition, **Appendix B** provides more information about general impacts of a catastrophic spill (**Appendix B**, "Catastrophic Spill Event Analysis"). However, it should be noted that the analysis in **Appendix B** was intended to be a general overview of potential effects of a catastrophic spill and to complement the substantive analyses in the main body of the EIS itself. It was never envisioned to replace such analyses for individual resources in the main body of the EIS. As such, the "Catastrophic Spill Event Analysis" should be read with the understanding that further detail about oil impacts on a particular resource can be found in the main body of the EIS or previous relevant NEPA documents.

The BOEM subject-matter experts, however, have clarified in this EIS where incomplete or unavailable information may be essential to a reasoned choice among alternatives, if the information could be obtained or if the costs of obtaining it are exorbitant, and that what scientifically credible information is available was applied using accepted scientific methodologies.

The Gulf of Mexico, including the CPA, is a dynamic environment that will be studied far into the future. There will never be a "final" assessment of baseline conditions in such an environment; any baseline would be constantly evolving. Nevertheless, BOEM has extensive experience in this environment, having held over 90 lease sales in the Gulf of Mexico, preparing over 50 lease sale EIS's, and continuing to study this ever-changing environment. The types of basic information included in the "Description of the Affected Environment" for each resource has been developed over many years, and new information is added on a regular basis. In this EIS, the subject-matter experts described new scientifically credible information on changes in baseline conditions as a result of the DWH spill, and this information was taken into account in analyzing the impacts of a proposed action on the various resources. In addition, three new resources were added to this EIS in consideration of the DWH spill. These included soft bottoms, *Sargassum*, and diamondback terrapins. It is BOEM's opinion that the discussion of baseline conditions in this EIS is robust and is, in fact, much more lengthy than recommended by NEPA guidelines.

Oceana comments that information on the "accepted scientific methods and approaches" should be explained or summarized by BOEM. The 153 pages of references for just **Chapters 1-4** are dominated by scientific research. In the vast majority of these references, the methods used to conduct the research are spelled out. These references are publicly available and the "scientific methodologies of research and modeling" would be too extensive to detail in an EIS. However, in numerous places in the EIS, where it was considered important, specific methodologies were summarized, for example the use of in-situ fluorescence and oxygen measurements as proxies for oil concentration and biodegradation to track the subsurface plume of oil from the DWH event.

Oceana-6 Climate change is a global phenomenon influenced by many activities worldwide. The BOEM's policy is to address programmatic issues such as global warming at the Five-Year Program level rather than at the individual lease sale level. It is not possible to tease out the impacts of an individual lease sale on climate change and, thus, the indirect effects are remote and speculative (e.g., see The South Louisiana Environmental Council, Inc. et al. and The Environmental Defense Fund, Inc. et al. v. Thomas A. Sands, U.S. Army Corps of Engineers, Etc., et al. and Morgan City Harbor and Terminal District (1980)).

In a recent court case, Native Village of Point Hope, et al., vs. Kenneth Salazar, et al. (2010), the U.S. District Court agreed with BOEM's conclusion that there would be no net effect (positive or negative) on climate change because of oil and gas development from a lease sale in the Chukchi Sea. This conclusion was based on the expectation that the level of oil and gas used in the U.S. would not likely change because of the resulting oil and gas production in the Chukchi Sea. Similarly, oil and gas use would not likely change due to the WPA and CPA proposed actions in this EIS. Thus, there is not a requirement to calculate the downstream consumption of oil and gas produced.

Oceana-7 Oceana comments that the Draft Multisale EIS fails to take a hard look at the persistent shortcomings in the regulation and safety of offshore oil and gas drilling. They further comment that the Draft Multisale EIS discussion of new regulations is imbalanced and is not full or fair. While we may respect those opinions, the discussion of the new regulations does not suggest that the regulations have solved all problems or eliminated all risks. It merely describes the new regulations that have been put in place to reduce the risk of spills or other accidents related to drilling. Increased independent testing of BOP's, redundancy of BOP's, negative pressure tests, etc., should lead to improved safety in drilling activities. We stand by the discussion of new regulations and disagree that it must be revised to be in compliance with NEPA.

ConocoPhillips

ConocoPhillips Company
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Houston, Texas 77252-2197

VIA E-MAIL: MultisaleEIS@BOEM.gov

February 13, 2012

Mr. Gary D. Goeke
Chief, Regional Assessment Section,
Office of the Environment (MS 5410)
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, Louisiana 70123-2394

Subject: Comments on the Draft Multisale EIS

Dear Mr. Goeke:

ConocoPhillips Company (ConocoPhillips) is pleased to provide comments on the Draft Environmental Impact Statement (EIS) covering the proposed 2012-2017 Gulf of Mexico's (GOM) Western Planning Area (WPA) and Central Planning Area (CPA) Outer Continental Shelf (OCS) oil and gas lease sales published December 2011 by the U.S. Department of Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region (BOEM).

ConocoPhillips is one of North America's leading energy producers, and one of our primary strategic objectives is to produce more oil and natural gas in the United States. We are a leading producer of natural gas in the United States, the largest producer of oil in Alaska, and among Canada's largest producers of natural gas (much of which flows to the U.S.). We are also the second largest refiner in the United States. We have major positions in most of the nation's leading producing basins with active exploration and development drilling programs. ConocoPhillips is known worldwide for its technological expertise in deepwater exploration and production, reservoir management and exploitation and 3-D seismic technology. In addition, ConocoPhillips recently bid over $173,000,000 on 97 blocks at the OCS Western Planning Area Lease Sale 218 on December 14, 2011. Therefore, ConocoPhillips has a direct and strong interest in the BOEM's offshore leasing program.

CONOCO-1

ConocoPhillips supports Alternative A. Under Alternative A, there would be a total of 10 lease sales in the WPA and CPA, and BOEM would offer for lease all unleased blocks within these planning areas, except the blocks within Flower Garden National Marine Sanctuary; former Western Gap, Transboundary Area; 100 miles of Florida coast; east of Military Mission line; and blocks beyond the U.S. Exclusive Economic Zone. ConocoPhillips does not support Alternatives B and C set forth in the EIS.

As stated in the EIS, the WPA and CPA sale areas encompass about 91 million acres and the estimated amount of resources projected to be developed as result of these sales are billions of barrels of oil. Oil from the WPA and CPA would help reduce the Nation's need for oil imports and lessen a growing dependence on foreign oil, and oil produced from the WPA and CPA would reduce the environmental risks associated with transoceanic oil tankering from sources overseas. The need for the proposed action (Alternative A) is to further the orderly development of OCS resources. Oil serves as the feedstock for liquid hydrocarbon products; among them gasoline, aviation and diesel fuel, and various petrochemicals. To exclude deepwater areas in the GOM from potential oil and gas exploration and development would not achieve the desired goal of reducing risk in the search for offshore oil and gas resources. The purpose and need for the oil and gas leasing program is to help meet the Nation's energy needs. ConocoPhillips agrees with the comments stated in the EIS as set forth above.

Clearly, the OCS contains potentially significant resources and conducting the lease sales set forth in the EIS is vitally important to America's energy security. In addition, these potentially significant, untapped resources of oil and natural gas are critically important to sustaining our national economic growth and maintaining much-needed jobs in virtually every sector of the economy. ConocoPhillips' continued commitment to the OCS will largely depend on the extent to which the BOEM's Oil and Gas Leasing Program makes high potential areas available for leasing.

ConocoPhillips supports Alternative A set forth in the EIS, which includes a total of 10 lease sales in the WPA and CPA. In addition, ConocoPhillips supports the comments set forth in the EIS comment letter sent by the American Petroleum Institute. ConocoPhillips appreciates the opportunity to comment on the EIS. Should you have any questions, please contact Jim Higgins at (281) 293-3139.

Sincerely,

Richard Lunam
Vice President, North America Exploration

ConocoPhillips Company

Conoco-1 Comment noted. The decision on which lease sale alternative will be chosen will be made by the Assistant Secretary for Land and Minerals at the time of the Final Notice of Sale.

January 20, 2012

Mr. Gary Goeke
Chief, Regional Assessment Section
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
Office of Environment (MS 54)
New Orleans, LA 70123-2394

RE: Please Increase Sea Turtle Safeguards from Oil and Gas Operations in EIS for OCS 2012-2017 Leases

I am writing because I deeply value and respect marine wildlife and urgently ask you to please prioritize sea turtles in the environmental scoping process for the Environmental Impact Statement for 2012 to 2017 Oil and Gas Leasing that is now underway.

It is urgent that oil and gas operations be completely re-evaluated and strong new protections mandated to protect sea turtles in new oil and gas lease regulations in the aftermath of the BP Deepwater Horizon oil spill.

After a reviewing the draft EIS, it is clear that lessons learned from the Deepwater Horizon tragedy about the deadly impacts of oil to endangered sea turtles and marine wildlife are not adequately addressed.

CAPOZZELLI-1

The highest priorities for protecting endangered and threatened sea turtles from oil and gas activities include that must be detailed in the final EIS are:

- Offshore oil and gas operations must avoid sea turtle breeding, foraging and migration habitat.
- Protected marine areas must be established in ocean feeding and migratory habitat for sea turtles in oil and gas lease areas in the Gulf of Mexico.
- New and existing offshore oil operations must be re-evaluated and modified in light of the BP oil spill to protect sea turtles and avoid harm or jeopardizing their existence as required under the Endangered Species Act.
- Oil and gas corporations must adopt rigorous monitoring and reporting schemes and fund new sea turtle research to better document the impacts of the full scope of oil and gas development, operations, oil spills and decommissioning on sea turtles and marine life.

CAPOZZELLI-2

In addition, the Sea Turtle Restoration Project recommends that all oil spill response and recovery plans should include these measures:

- Independent observers on all oil spill response vessels to record wildlife sightings.
- Sea turtle rescuers be required on all cleanup vessel teams.
- Double or triple the number of qualified wildlife rescue teams on-call.
- Establishment of a volunteer protocol for wildlife rescue assistance workers.
- Maintenance of an effective level of search effort for sea turtles and wildlife.
- Endangered species prioritized for rescue and rehabilitation.
- Sea turtle nesting beaches prioritized for placement of offshore oil booms.
- Chemical dispersants and "controlled burns" banned where endangered species are present.

Thank you for your help on behalf of sea turtles and a healthy marine environment.

Yours respectfully, J. Capozzelli, New York

J. Capozelli

Capozelli-1 As noted in this Multisale EIS, protocols described in this document may be implemented to protect sea turtles. The BOEM and BSEE will continue to comply with all reasonable and prudent alternative measures and the terms and conditions of consultations with NMFS and FWS. Potential mitigation measures are discussed in **Chapters 2 and 4** of the Final Multisale EIS. The BOEM will continue to consult with NMFS and, during the postlease approval process, BOEM and BSEE may consider imposing additional mitigations or conditions of approval where appropriate to minimize or avoid impacts on sea turtles.

With respect to requesting the creation of additional protected marine sanctuaries, NOAA's National Marine Sanctuaries Program has exclusive jurisdiction over the creation and protection of such areas. The BOEM does not have the authority over the creation of marine sanctuaries. There are currently no specific marine sanctuaries designated for the specific protection of sea turtles in the Gulf. For marine sanctuaries that have been designated by NOAA, BOEM complies with all No Activity Zones in place to protect those sanctuaries. In addition, across the Gulf, BOEM has sea turtle and marine mammal mitigations in place as described in this document.

The BOEM already requires operators to monitor their activities as they relate to sea turtles and marine mammals, and it imposes additional mitigations as appropriate. For example, 30 CFR 250.282, 30 CFR 550.282, and NTL 2012-JOINT-G04 provide guidelines for monitoring procedures and vessel strike avoidance measures for sea turtles and other protected species. These mitigations and monitoring requirements are described in **Chapter 4**.

The BOEM and BSEE continually evaluate offshore oil operations under their jurisdiction to ensure that our Nation's offshore energy reserves are managed and developed in the most environmentally sound and safe manner possible. To this end, BSEE promulgated new regulations on drilling safety and new requirements for supplemental environmental management systems in light of lessons learned from the DWH event.

Studies and information on sea turtles are evolving, and the NRDA process is continuing to investigate potential impacts to sea turtles in light of the DWH event.

Capozelli-2 Comment noted. See the response to comment Capozelli-1. The BOEM and BSEE are continuing to consult with NMFS and FWS on how best to protect threatened and endangered species, including sea turtles. These agencies are working cooperatively to determine how best to protect sea turtles and other species in the Gulf in light of OCS activities.

Comments for Public Meeting for the Draft Multisale EIS on Proposed 2012-2017 Oil and Gas lease sales in the Gulf of Mexico's Western and Central Planning Areas.
Mobile, AL 12 Jan 2012

KLOTZ-1

1. Oil and gas from the Gulf is pretty much a national necessity —we, citizens and our government officials, need to make it less necessary! So my first question is how much oil and gas do we need? In determining quantity needed, I believe the federal government has an obligation to take into consideration and promote alternative measures and energy sources in their planning. Individual members of the public need to be better informed of the importance of energy conservation in their daily lives and most importantly, to act accordingly. This requires more than just education--- a change in our environmental culture needs to be promoted

KLOTZ-2

2. Encourage use of solar panels in Gulf States. -- in Cape Cod, MA, an alliance between State, federal, and power companies foster installation of solar panels on roof tops. A colleague of mine, who lives on Cape Cod, uses so little energy from the utility company, that he pays little or no power bill. Some months, when it is not too cloudy, he receives a rebate on his power bill. The sun is not as bright in MA as it is on the Gulf! The Gulf Coast States and their various power companies along with the Federal Government need to initiate similar energy saving programs. -- Solar needs to happen

KLOTZ-3

3. Encourage more efficient transportation of freight by increased utilization of waterways and rail by pursuing investment in water and rail infrastructure. I would rather see the billion dollars, estimated by highway departments for a new Interstate Highway (I-10) bridge crossing Mobile Bay, be spent on water and rail infrastructure. The bridge will both, be an encouragement to inefficient highway transportation and be a detriment to smart growth in downtown Mobile. Also, nationwide encouragement of carpooling and public transportation is a key element of transportation energy efficiency and must be pursued. -- This relates to the culture change previously mentioned.

KLOTZ-4

4. Hopefully new safety standards following the BP oil spill will help protect the environment. I always thought that the blowout preventer (BOP) was a reasonable precaution against massive spills, and it likely still is. Deep water technology for effective BOP operation was available but not utilized by BP or their contractors in the Gulf; also, investigations have disclosed that existing standards for drilling equipment maintenance and drilling operations were not followed by BP and their contractors. So to my last point; -- Monetary fines and cleanup expenses are obviously just routine costs of doing business for oil companies; and unfortunately, I believe, are sometimes less costly than the price of following safe operating procedures. Over the long haul, these penalty costs are simply passed on to the consumers. We all pay for their mistakes and negligence! Even with good comprehensive regulations and guidelines, history has proven that we cannot depend on operators to follow standards and do the right thing in the face of declining profits. --- Executives and managers of drilling operations need to have a realistic expectation that if they defy laws, regulations and industry safety standards, they are going to prison!

If action on any of these comments is not within the preview of an agency in the Department of Interior; please forward a copy to the appropriate agency.

Thank you for the opportunity to be heard.

John W. Klotz

Cc: Representative Jo Bonner,
Mobile Bay Keeper

John W. Klotz

Klotz-1	Comment noted.
Klotz-2	Comment noted.
Klotz-3	Comment noted.
Klotz-4	Comment noted. **Chapter 1.3.1** of the Multisale EIS provides detailed descriptions of the administrative and regulatory changes made by this Agency following the DWH event and oil spill, all of which are designed to minimize the risk of future blowouts and oil spills. **Chapter 1.3.1** describes the regulatory framework and the current research being accomplished to strengthen the regulations and protective measures on the OCS..

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.