OCS EIS/EA
BOEM 2011-057

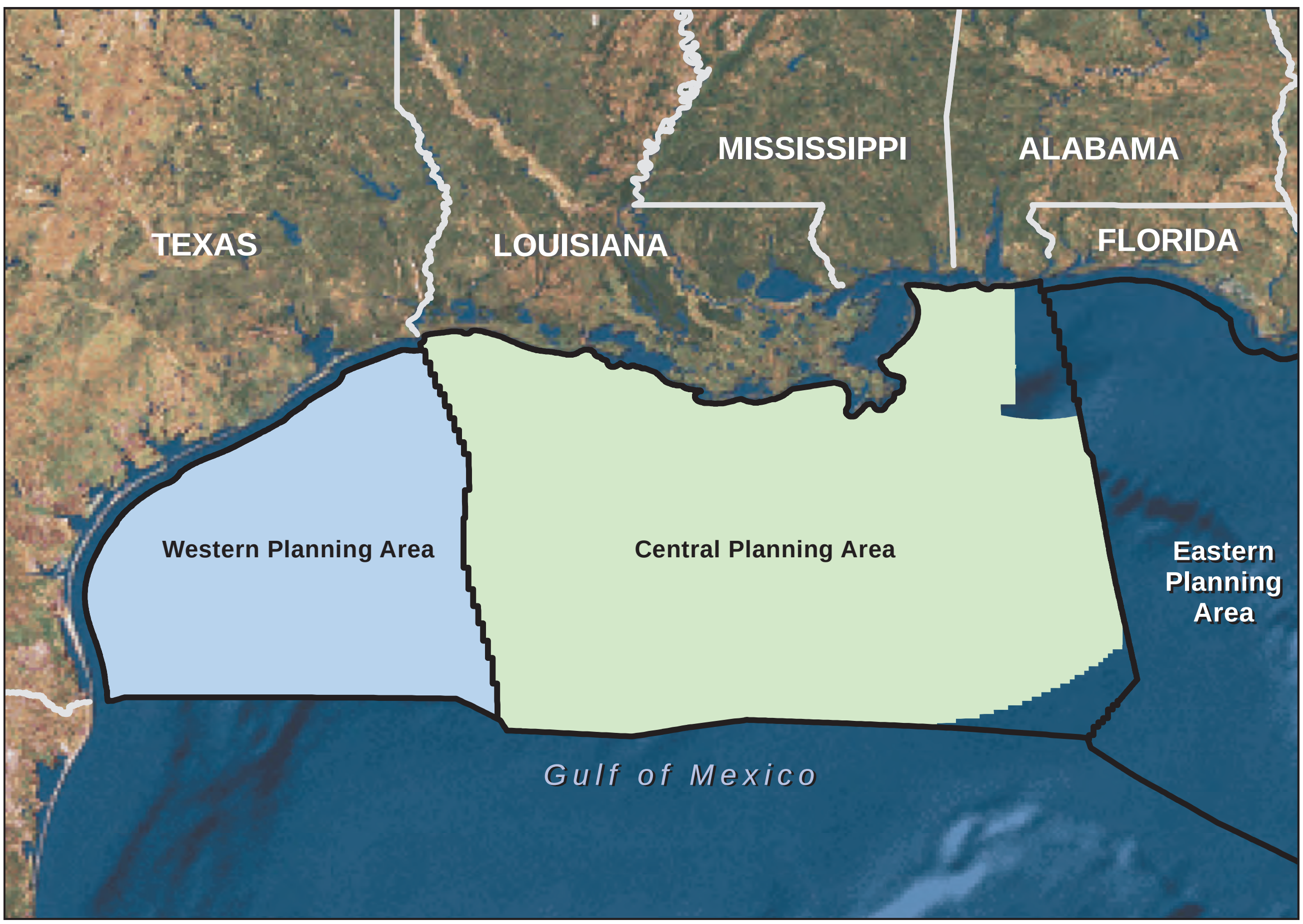
Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017

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

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

Draft Environmental Impact Statement

Volume I: Chapters 1-4.1



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

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REGIONAL DIRECTOR'S NOTE

In the *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017,* five annual areawide lease sales are scheduled for the Western Planning Area and five annual areawide lease sales are scheduled for the Central Planning Area. Federal regulations allow for several related or similar proposals to be analyzed in one environmental impact statement (EIS) (40 CFR 1502.4). Since each lease sale proposal and projected activities are very similar each year for each sale area, the Bureau of Ocean Energy Management (BOEM) has prepared a single EIS for the 10 lease sales: *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, Draft Environmental Impact Statement.*

This Draft EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. It is important to note that this Draft EIS was prepared using the best information that was publicly available at the time the document was prepared.

At the completion of this EIS process, a decision will be made only for proposed Lease Sale 229 in the Western Planning Area and proposed Lease Sale 227 in the Central Planning Area.

The BOEM's Gulf of Mexico OCS Region and its predecessors have been conducting environmental analyses of the effects of Outer Continental Shelf (OCS) oil and gas development since the inception of the National Environmental Policy Act of 1969. We have prepared and published more than 50 draft and final EIS's. Our goal has always been to provide factual, reliable, and clear analytical statements in order to inform decisionmakers and the public about the environmental effects of proposed OCS activities and their alternatives. We view the EIS process as providing a balanced forum for early identification, avoidance, and resolution of potential conflicts. It is in this spirit that we welcome comments on this document from all concerned parties.

John L. Rodi

John L. Rodi
Regional Director
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

COVER SHEET

Environmental Impact Statement for Proposed Western Planning Area
OCS Oil and Gas Lease Sales 229, 233, 238, 246, and 248,
and Proposed Central Planning Area
OCS Oil and Gas Lease Sales 227, 231, 235, 241, and 247

	Draft (x)	**Final ( )**
Type of Action:	Administrative (x)	Legislative ( )

Area of Potential Impact: Offshore Marine Environment and Coastal Counties/Parishes of Texas, Louisiana, Mississippi, Alabama, and northwestern Florida

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ABSTRACT

This Draft Environmental Impact Statement (EIS) covers the proposed 2012-2017 Gulf of Mexico's Western Planning Area and Central Planning Area OCS oil and gas lease sales. The proposed Western Planning Area 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 proposed actions are major Federal actions requiring an EIS. This document provides the following information in accordance with the National Environmental Policy Act and its implementing regulations, and it will be used in making decisions on the proposal. This document includes the purpose and background of the proposed actions, identification of the alternatives, description of the affected environment, and an analysis of the potential environmental impacts of the proposed actions, alternatives, and associated activities, including proposed mitigating measures and their potential effects. Potential contributions to cumulative impacts resulting from activities associated with the proposed actions are also analyzed.

Hypothetical scenarios were developed on the levels of activities, accidental events (such as oil spills), and potential impacts that might result if the proposed actions are adopted. Activities and disturbances associated with the proposed actions on biological, physical, and socioeconomic resources are considered in the analyses.

Additional copies of this Draft EIS and the other referenced publications may be obtained from the Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, Public Information Office (MS 5034), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394, by telephone at 504-736-2519 or 1-800-200-GULF, or on the Internet at http://www.boem.gov.

SUMMARY

This environmental impact statement (EIS) addresses 10 proposed Federal actions that offer for lease areas on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) that may contain economically recoverable oil and gas resources. 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. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since each lease sale proposal and projected activities are very similar each year for each sale area, a single EIS is being prepared for the 10 WPA and CPA lease sales. At the completion of this EIS process, decisions will be made only for proposed Lease Sale 229 in the WPA and proposed Lease Sale 227 in the CPA. A National Environmental Policy Act (NEPA) review will be conducted before each subsequent proposed lease sale.

This summary section is only a brief overview of the proposed lease sales, alternatives, significant issues, potential environmental and socioeconomic effects, and proposed mitigating measures contained in this EIS. To obtain the full perspective and context of the potential environmental and socioeconomic impacts discussed, it is necessary to read the entire analyses. Relevant discussions can be found in the chapters of this EIS as described below.

- **Chapter 1**, The Proposed Actions, describes the purpose of and need for the proposed lease sales, the prelease process, postlease activities, and other OCS-related activities.
- **Chapter 2**, Alternatives Including the Proposed Actions, describes the environmental and socioeconomic effects of the proposed lease sales and alternatives. Also discussed are potential mitigating measures to avoid or minimize impacts.
- **Chapter 3**, Impact-Producing Factors and Scenario, describes activities associated with the proposed lease sales and the OCS Program, and other foreseeable activities that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico.

  Chapter 3.1, Impact-Producing Factors and Scenario—Routine Operations, describes offshore infrastructure and activities (impact-producing factors) associated with the proposed lease sales that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico.

  Chapter 3.2, Impact-Producing Factors and Scenario—Accidental Events, discusses potential accidental events (i.e., oil spills, losses of well control, vessel collisions, and spills of chemicals or drilling fluids) that may occur as a result of activities associated with the proposed lease sales.

  Chapter 3.3, Cumulative Activities Scenario, describes past, present, and reasonably foreseeable future human activities, including non-OCS activities, as well as all OCS activities, that may affect the biological, physical, and socioeconomic resources of the Gulf of Mexico.

- **Chapter 4**, Description of the Environment and Impact Analysis, describes the affected environment and provides analysis of the routine, accidental, and cumulative impacts of the proposed actions and the alternatives on environmental and socioeconomic resources of the Gulf of Mexico.

Chapter 4.1, Proposed Western Planning Area Lease Sales 229, 233, 238, 246, and 248, describes the impacts of the proposed actions and two alternatives to the WPA proposed actions on the biological, physical, and socioeconomic resources of the Gulf of Mexico.

Chapter 4.2, Proposed Central Planning Area Lease Sales 227, 231, 235, 241, and 247, describes the impacts of the proposed actions and two alternatives to the CPA proposed actions on the biological, physical, and socioeconomic resources of the Gulf of Mexico.

Chapter 4 also includes **Chapter 4.3**, Unavoidable Adverse Impacts of the Proposed Action; **Chapter 4.4**, Irreversible and Irretrievable Commitment of Resources; and **Chapter 4.5**, Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity.

- **Chapter 5**, Consultation and Coordination, describes the consultation and coordination activities with Federal, State, and local agencies and other interested parties that occurred during the development of this EIS.
- **Chapter 6**, References Cited, is a list of literature cited throughout this EIS.
- **Chapter 7**, Preparers, is a list of names of persons who were primarily responsible for preparing and reviewing this EIS.
- **Chapter 8,** Glossary, is a list of specialized words with brief definitions used in this document.

Proposed Action and Alternatives

The following alternatives were included for analysis in this EIS.

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 (**Figure 2-1**), 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 be postponed. This is analyzed in the EIS for the 5-Year Program on a nationwide programmatic level.

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 (**Figure 2-1**), 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.

Mitigating Measures

Proposed lease stipulations and other mitigating measures designed to reduce or eliminate environmental risks and/or potential multiple-use conflicts between OCS operations and U.S. Department of Defense activities may be applied to the chosen alternative. Four lease stipulations are proposed for a proposed WPA lease sale—the Topographic Features Stipulation, the Military Areas Stipulation, the Protected Species Stipulation, and the Law of the Sea Convention Royalty Payment Stipulation. The Law of the Sea Convention Royalty Payment Stipulation is applicable to a WPA lease sale even though it is not an environmental or military stipulation. The Naval Mine Warfare Area Stipulation is no longer applicable to the WPA lease sale area by memorandum dated April 3, 2009, from the Department of the Navy. Eight lease stipulations are proposed for a CPA lease sale—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; and the Law of the Sea Convention Royalty Payment Stipulation.

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.

Scenarios Analyzed

Offshore activities are described in the context of scenarios for a proposed action (**Chapter 3.1**) and for the OCS Program (**Chapter 3.3**). The Bureau of Ocean Energy Management's (BOEM's) Gulf of Mexico OCS Region developed these scenarios to provide a framework for detailed analyses of potential impacts of a proposed lease sale. The scenarios are presented as ranges of the amounts of undiscovered, unleased hydrocarbon resources estimated to be leased and discovered as a result of a proposed action. The analyses are based on a traditionally employed range of activities (e.g., the installation of platforms, wells, and pipelines, and the number of helicopter operations and service-vessel trips) that would be needed to develop and produce the amount of resources estimated to be leased.

The cumulative analysis (**Chapter 4**) considers environmental and socioeconomic impacts that may result from the incremental impact of a proposed action when added to all past, present, and reasonably foreseeable future activities, including non-OCS activities such as import tankering and commercial fishing, as well as all OCS activities (OCS Program). 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. In addition to human activities, impacts from natural occurrences, such as hurricanes, are analyzed.

Significant Issues

The major issues that frame the environmental analyses in this EIS are the result of concerns raised during years of scoping for the Gulf of Mexico OCS Program. Issues related to OCS exploration, development, production, and transportation activities include the potential for oil spills, wetlands loss, air emissions, discharges, water quality degradation, trash and debris, structure and pipeline emplacement activities, platform removal, vessel and helicopter traffic, multiple-use conflicts, support services, population fluctuations, demands on public services, land-use planning, impacts to tourism, aesthetic interference, cultural impacts, environmental justice, and conflicts with State coastal zone management programs. Environmental resources and activities identified during the scoping process to warrant an environmental analysis include air quality, water quality, coastal barrier beaches and associated dunes, wetlands, seagrass communities, topographic features, *Sargassum*, deepwater benthic communities, soft-bottom benthic communities, marine mammals, sea turtles, diamondback terrapins, coastal and marine birds, fish resources and essential fish habitat, commercial and recreational fishing, recreational resources, archaeological resources, socioeconomic conditions, and within the CPA only, beach mice, live bottoms, and Gulf sturgeon.

Other relevant issues include impacts from the *Deepwater Horizon* (DWH) event and from past and future hurricanes on environmental and socioeconomic resources, and on coastal and offshore infrastructure. During the past few years, the Gulf Coast States and Gulf of Mexico oil and gas activities have been impacted by major hurricanes. The description of the affected environment (**Chapters 4.1 and 4.2**) includes impacts from these storms on the physical environment, biological environment, and socioeconomic activities and OCS-related infrastructure. Baseline data are considered in the assessment of impacts from a proposed action to the resources and the environment (**Chapters 4.1 and 4.2)**.

Impact Conclusions

The full analyses of the potential impacts of routine activities and accidental events associated with the WPA and CPA proposed actions and the proposed actions' incremental contribution to the cumulative impacts are described in **Chapters 4.1 and 4.2**. A summary of the potential impacts from the proposed actions on each environmental and socioeconomic resource and the conclusions of the analyses can be found below.

Air Quality: Emissions of pollutants into the atmosphere from the routine activities associated with the proposed actions 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 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 hydrogen sulfide (H_2S) could result in deaths as well as environmental damage. These emissions from routine activities and accidental events associated with the proposed actions are not expected to occur at concentrations that would change onshore air quality classifications.

Coastal and Offshore Waters: Impacts from routine activities associated with a WPA or 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 run-off 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 meters (m) (328 feet [ft]) adjacent to the point of discharge. Structure installation and removal and pipeline placement disturb the sediments and cause increased turbidity. In addition, offshore water impacts result from supply and service-vessel bilge and ballast water discharges.

Coastal Barrier Beaches and Associated Dunes: Routine activities associated with a WPA or CPA proposed action, such as increased vessel traffic, maintenance dredging of navigation canals, and pipeline installation, would cause negligible impacts. Such impacts would be expected to be restricted to temporary and localized disturbances and not deleteriously affect 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 WPA or CPA proposed action are anticipated to be minimal. 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 WPA or CPA proposed action. The incremental contribution of a WPA or CPA proposed action to the cumulative impacts of coastal barriers and their associated dunes is expected to be small and localized. 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 are expected to be small in comparison.

Wetlands: Routine activities associated with a WPA or CPA proposed action are expected to be small, localized, and temporary due to the small length of projected onshore pipelines, the minimal contribution to the need for maintenance dredging, the disposal of OCS wastes, and the mitigation measures that would be used to further reduce these impacts. Indirect impacts from wake erosion and saltwater intrusion are expected to result in low impacts that are indistinguishable from direct impacts from inshore activities. The potential impacts from accidental events (primarily oil spills, excepting catastrophic spills) are anticipated to be minimal. Overall, impacts to wetland habitats from an oil spill associated with activities related to a WPA or CPA proposed action would be expected to be small and temporary because of the nature of the system, regulations, and specific cleanup techniques. 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, particularly in Louisiana. The incremental contribution of a WPA or CPA proposed action to the cumulative impacts on coastal wetlands is expected to be small.

Seagrass Communities: Turbidity impacts from pipeline installation and maintenance dredging associated with the proposed actions would be temporary and localized. The increment of impacts from service-vessel transit associated with the proposed actions would be minimal. 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. 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.

Live Bottoms (Pinnacle Trend and Low Relief): The combination of its depth (200-400 ft; 60-120 m), separation from sources of impacts as mandated by the Live Bottom (Pinnacle Trend and Low Relief) Stipulation and through site-specific seafloor reviews of proposed activity, and a community adapted to sedimentation makes damage to the ecosystem unlikely from routine activities associated with a CPA proposed action. In the unlikely event that oil from a subsurface spill would reach the biota of these communities, the effects would be primarily sublethal for adult sessile biota, and there would be limited incidences of mortality.

Topographic Features: The routine activities associated with the proposed actions that would impact topographic feature communities include anchoring, infrastructure and pipeline emplacement, infrastructure removal, drilling discharges, and produced-water discharges. However, adherence to the proposed Topographic Features Stipulation would make damage to the ecosystem unlikely. Contact with accidentally spilled oil would cause lethal and sublethal effects in benthic organisms, but the oiling of benthic organisms is not likely because of the small area of the banks, the scattered occurrence of spills, the depth of the features, and because the proposed Topographic Features Stipulation, if applied, would keep subsurface sources of spills away from the immediate vicinity of topographic features.

Sargassum: The impacts to *Sargassum* that are associated with the proposed actions 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 from the proposed actions.

Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities: Chemosynthetic and nonchemosynthetic communities are susceptible to physical impacts from structure placement, anchoring, and pipeline installation associated with the proposed actions. However, the policy requirements described in Notice to Lessees and Operators (NTL) 2009-G40 greatly reduce the risk of these physical impacts by clarifying the measures that must be taken to ensure avoidance of potential chemosynthetic communities and, by consequence, avoidance of other hard-bottom communities. Even in situations where substantial burial of typical benthic infaunal communities occurred, recolonization by populations from 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 the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities and the widespread, typical, deep-sea benthic communities.

Soft-Bottom Habitats: The routine activities associated with a WPA or CPA proposed action that would impact soft bottoms generally occur within a few hundred meters of platforms, and the greatest impacts are seen close to the platform communities. 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 WPA (115,645 square kilometers [km^2]; 44,651 square miles [mi^2]) or the CPA (268,922 km^2; 103,831 mi^2). The WPA or CPA proposed action 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 the soft-bottom benthic communities are ubiquitous throughout the GOM.

Marine Mammals: Routine events related to a WPA or CPA proposed action are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population in the northern GOM. Characteristics of impacts from accidental events depend on chronic or acute exposure from accidental events resulting in harassment, harm, or mortality to marine mammals, while exposure to dispersed hydrocarbons is likely to result in sublethal impacts.

Sea Turtles: Routine activities resulting from a WPA or 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 Gulf of Mexico and mitigations that are in place. Accidental events associated with a WPA and CPA proposed action have the potential to impact small to large numbers of sea turtles. Populations of sea turtles in the northern Gulf of Mexico may be exposed to residuals of oils spilled as a result of WPA or CPA proposed action during their lifetimes. While chronic or acute exposure from accidental events may result in the harassment, harm, or mortality to sea turtles, in the most likely scenarios, 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. The incremental contribution of a WPA or CPA proposed action would not be likely to result in a significant incremental impact on sea turtles within the WPA and CPA; in comparison, non-OCS energy-related activities, such as overexploitation, commercial fishing, and pollution, have historically proved to be of greater threat to the sea turtle species.

Diamondback Terrapins: The routine activities of a WPA or CPA proposed action are unlikely to have significant adverse effects on the size and recovery of terrapin species or populations in the GOM.

Impacts on diamondback terrapins from smaller accidental events are likely to affect individual diamondback terrapins in the spill area, but they are unlikely to rise to the level of population effects (or significance) given the probable size and scope of such spills. Due to the distance of most terrapin habitat from offshore OCS energy-related activities, impacts associated with activities occurring as a result of a WPA or CPA proposed action are not expected to impact terrapins or their habitat. The incremental effect of a WPA or CPA proposed action on diamondback terrapin 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.

Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice: An impact from the 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 extinction, and, if all personnel are not thoroughly trained, oil-spill response and cleanup activities could have a significant impact to the beach mice and their habitat.

Coastal and Marine Birds: The majority of impacts resulting from routine activities associated with a WPA or CPA proposed action on threatened and endangered and nonthreatened and nonendangered avian species are expected to be adverse, but not significant. These impacts 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. Impacts from potential oil spills associated with a WPA or CPA proposed action and the effects related to oil-spill cleanup are expected to be adverse, but not significant. Oil spills, irrespective of size, can result in some mortality as well as sublethal, chronic short- and long-term effects, in addition to potential impacts to food resources. The effect of cumulative activities on coastal and marine birds is expected to result in discernible changes to avian species composition, distribution, and abundance. The incremental contribution of a WPA or CPA proposed action to cumulative impacts is expected to be adverse, but not significant, because it may seriously alter avian species composition and abundance due to reductions in the overall carrying capacity of disturbed habitats, and possibly to the availability, abundance, and distribution of preferred food resources.

Gulf Sturgeon: Routine activities associated with a WPA or CPA proposed action, such as the installation of pipelines, maintenance dredging, potential vessel strikes, and nonpoint-source runoff from onshore facilities, would cause negligible impacts and would not deleteriously affect Gulf sturgeon. Indirect impacts from routine activities to inshore habitats are negligible and indistinguishable from direct impacts of inshore activities and are further reduced through mitigations and regulations. The potential impacts from accidental events, mainly oil spills associated with a WPA or CPA proposed actions, are anticipated to be minimal. Because of the floating nature of oil, reduced toxicity through weathering (offshore dispersant treatment) and the small tidal range of the Gulf of Mexico, oil spills alone would typically have very little impact on benthic feeders such as the Gulf sturgeon. The incremental contribution of a WPA or CPA proposed action to the cumulative impact is negligible.

Fish Resources and Essential Fish Habitat: Fish resources and essential fish habitat could be impacted by coastal environmental degradation potentially caused by canal dredging, increases in infrastructure, and inshore spills and marine environmental degradation possibly caused by pipeline trenching, offshore discharges, and offshore spills. Impacts of routine dredging and discharges are localized in time and space and are regulated by Federal and State agencies through permitting processes; therefore, there would be minimal impact to fish resources and essential fish habitat from these routine activities associated with a WPA or CPA proposed action. Accidental events that could impact fish resources and essential fish habitat include blowouts and oil or chemical spills. If a spill were to occur as a result of a WPA or CPA proposed action and if it was proximate to mobile fishes, the impacts of the spill would depend on multiple factors including the amount spilled, the areal extent of the spill, the distance of the spill from particular essential fish habitats (e.g., nursery habitats), and the type and toxicity of oil spilled. Much of the sensitive essential fish habitat would have decreased effects from oil spills because of the depths many are found and because of the distance these low-probability spills would occur from many of the essential fish habitats (due to stipulations, NTL’s, etc.). If there is an effect of an oil spill on fish resources in the Gulf of Mexico, it is expected to cause a minimal decrease in standing stocks of any population. This is because most spill events would be localized, therefore affecting a small potion of fish populations.

Commercial Fishing: Routine activities in the WPA and 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 inshore activities on commercial fisheries. The potential impacts from accidental events, such as a well blowout or an oil spill, associated with the proposed actions are anticipated to be minimal. Commercial fishermen are anticipated to avoid the area of a well blowout or an oil spill. Large spills may impact commercial fisheries by area closures. The extent of impact depends on the areal extent and length of the closure. The impact of spills on catch or value of catch would depend on the volume and location (i.e., distance from shore) of the spill, as well as the physical properties of the oil spilled.

Recreational Fishing: There could be minor and short-term, space-use conflicts with recreational fishermen during the initial phases of a WPA or CPA proposed action. A WPA or CPA proposed action could also lead to low-level environmental degradation of fish habitat, which would also negatively impact recreational fishing activity. However, these minor negative effects would be offset by the beneficial role that oil platforms serve as artificial reefs for fish populations. An oil spill would likely lead to recreational fishing closures in the vicinity of the oil spill. Except for a catastrophic spill such as the DWH event, oil spills should not affect recreational fishing to a large degree due to the likely availability of substitute fishing sites in neighboring regions.

Recreational Resources: Routine OCS actions can cause minor disturbances to recreational resources, particularly beaches, through increased levels of noise, debris, and rig visibility. The oil spills most likely to result from a WPA or 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, except for a catastrophic spill such as the DWH event, these effects are likely to be small in scale and of short duration.

Historic and Prehistoric Archaeological Resources: The greatest potential impact to an archaeological resource as a result of routine activities associated with a WPA or CPA proposed action would result from direct contact between an offshore activity (e.g., platform installation, drilling rig emplacement, structure removal or site clearance operation, and dredging or pipeline project) and a historic or prehistoric site. 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 highly effective at identifying possible offshore archaeological sites; however, should such contact occur, there would be localized damage to or loss of significant and/or unique archaeological information. It is expected that coastal archaeological resources would be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

It is not very likely that a large oil spill would occur and contact coastal prehistoric or historic archaeological sites from accidental events associated with a WPA or CPA proposed action. 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 resulting in the irreversible loss of unique or significant archaeological information. The major effect from an oil-spill impact on coastal historic archaeological sites would be visual contamination, which, while reversible, could result in additional impacts to fragile cultural materials from the cleaning process.

Land Use and Coastal Infrastructure: A WPA or CPA proposed action would not require additional coastal infrastructure, with the exception of possibly one new gas processing facility and one new pipeline landfall, and it would not alter the current land use of the analysis area. The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a WPA or 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 analysis area, should it be needed. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills, as well as vessel collisions, could have short-term adverse effects on coastal infrastructure, requiring cleanup of any oil or chemicals spilled.

Demographics: A WPA or CPA proposed action is projected to minimally affect the demography of the analysis area. Population impacts from a WPA or CPA proposed action are projected to be minimal

(<1% of total population) for any economic impact area in the Gulf of Mexico region. The baseline population patterns and distributions, as projected and described in **Chapters 4.1.1.20 and 4.2.1.23**, are expected to remain unchanged as a result of a CPA or WPA 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 (from elsewhere within or outside the U.S.), which is projected to move into focal areas such as Port Fourchon. Accidental events associated with a WPA or 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.

Economic Factors: A WPA or CPA proposed action is expected to generate a <1 percent increase in employment in any of the coastal subareas, even when the net employment impacts from accidental events are included. Most of the employment related to a WPA or CPA proposed action is expected to occur in Louisiana and Texas. The demand would be met primarily with the existing population and labor force.

Environmental Justice: 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.

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ABBREVIATIONS AND ACRONYMS

°C	degree Celsius
°F	degree Fahrenheit
2009-2012 Supplemental EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2009-2012; Central Planning Area Sales 208, 213, 216, and 222; Western Planning Area Sales 210, 215, and 218; Final Supplemental Environmental Impact Statement*
2D	two-dimensional
3D	three-dimensional
4D	four-dimensional
5-Year Program	*Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012*
5-Year Program EIS	*Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012, Final Environmental Impact Statement*
ac	acre
ACP	Area Contingency Plans
ANPR	Advance Notice of Proposed Rulemaking
APD	Application for Permit to Drill
APE	area of potential effect
API	American Petroleum Institute
ASLM	Assistant Secretary of the Interior for Land and Minerals
BAST	best available and safest technology
bbl	barrel
BBO	billion barrels of oil
B.C.	before Christ
Bcf	billion cubic feet
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
B.P.	before present
BP	British Petroleum
BSEE	Bureau of Safety and Environmental Enforcement
BTEX	benzene, ethylbenzene, toluene, and xylene
CAA	Clean Air Act of 1970
CAAA	Clean Air Act Amendments of 1990
CD	Consistency Determination
CDP	common-depth-point (seismic surveying)
CEEDS	*Complete Economic and Demographic Data Source*
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CER	categorical exclusion review
CFR	Code of Federal Regulations
CG	Coast Guard (also: USCG)
CH_4	methane
CIAP	Coastal Impact Assistance Program
cm	centimeter
CMP	Coastal Management Plans
CO	carbon monoxide
CO_2	carbon dioxide
COE	Corps of Engineers (U.S. Army)
COF	covered offshore facilities
CPA	Central Planning Area
CPS	coastal political subdivisions
CRS	Congressional Research Service

CSA	Continental Shelf Associates
CWPPRA	Coastal Wetlands Protection, Planning & Restoration Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
dB	decibel
DOCD	development operations coordination document
DOD	Department of Defense (U.S.)
DOE	Department of Energy (U.S.) (also: USDOE)
DOI	Department of the Interior (U.S.) (also: USDOI)
DOT	Department of Transportation (U.S.) (also: USDOT)
DPP	development and production plan
DWH	*Deepwater Horizon*
DWOP	deepwater operations plan
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
e.g.	for example
Eh	oxidation reduction potential
EIA	Economic Impact Area
EIA	Energy Information Administration (USDOE)
EIS	environmental impact statement
EP	exploration plan
EPA	Eastern Planning Area
EPAct	Energy Policy Act of 2005
ERCO	Energy Resources Co., Inc.
ESA	Endangered Species Act of 1973
ESI	Environmental Sensitivity Indexes
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
et al.	and others
et seq.	and the following
EWTA	Eglin Water Test Area
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FPSO	floating production, storage, and offloading system
FR	*Federal Register*
ft	feet
FWS	Fish and Wildlife Service
FY	fiscal year
G&G	geological and geophysical
gal	gallon
GAO	Government Accountability Office (U.S.)
GCCF	Gulf Coast Claims Facility
GCERTF	Gulf Coast Ecosystem Restoration Task Force
GERG	Geochemical and Environmental Research Group
GIWW	Gulf Intracoastal Waterway
GMAQS	Gulf of Mexico Air Quality Study
GMFMC	Gulf of Mexico Fishery Management Council
GOADS	Gulfwide Offshore Activities Data System
GOM	Gulf of Mexico
GOMESA	Gulf of Mexico Energy Security Act of 2006
GS	Geological Survey (also: USGS)
H_2S	hydrogen sulfide
ha	hectare
hr	hour

i.e.	specifically
IATAP	Interagency Alternative Technology Assessment Program
in	inch
ITOPF	International Tanker Owners Pollution Federation Limited
ITS	Incidental Take Statement
JIP	Joint Industry Project
kg	kilogram
km	kilometer
kn	knot
LA	Louisiana
LA Hwy 1	Louisiana Highway 1
LACPR	Louisiana Coastal Protection and Restoration
lb	pound
LC_{50}	lethal concentration for 50 percent of the test population
LCA	Louisiana Coastal Area
LMA	labor market area
LMRP	lower marine riser package
LNG	liquefied natural gas
m	meter
MARAD	U.S. Department of Transportation Maritime Administration
MARPOL	International Convention for the Prevention of Pollution from Ships
Mcf	thousand cubic feet
mg	milligram
mg/L	milligrams per liter
mi	mile
ml/L	milliliter per liter
mm	millimeter
MMbbl/d	million barrels per day
MMcf	million cubic feet
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MOA	Memorandum of Agreement
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
mph	miles per hour
Multisale EIS	*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; Final Environmental Impact Statement; Volumes I and II*
MWCC	Marine Well Containment Company
N.	north
n.d.	no date
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NGMCS	Northern Gulf of Mexico Continental Slope Study
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
nmi	nautical-mile
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Prepare an EIS

NOS	National Ocean Service
NPDES	National Pollutant and Discharge Elimination System
NPR	Notice of Proposed Rulemaking
NPS	National Park Service
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NTL	Notice to Lessees and Operators
NUT	new or unusual technology
O_3	ozone
OBF	oil-based fluids
OBM	oil-based muds
OCD	Offshore and Coastal Dispersion Model
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODMDS	ocean dredged-material disposal sites
OIG	Office of the Inspector General
OPA	Oil Pollution Act of 1990
OSAT	Operational Science Advisory Team
OSFR	oil-spill financial responsibility
OSHA	Occupational Safety and Health Administration
OSRA	Oil Spill Risk Analysis
OSRP	oil-spill response plans
OSV	offshore supply/service vessels
P.L.	Public Law
PAH	polycyclic aromatic hydrocarbon
pH	potential of hydrogen
PINC	Potential Incident of Noncompliance
PM	particulate matter
ppb	part per billion
ppm	parts per million
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
psu	practical salinity unit
QOCSR	qualified OCS revenues
ROD	Record of Decision
ROTAC	Regional Operations Technology Assessment Committee
ROV	remotely operated vehicle
RP	Recommended Practice
RPM	reasonable and prudent measure
RRT	Regional Response Team
RTR	Rigs-to-Reef
S.	south
SAV	submerged aquatic vegetation
SBF	synthetic-based fluids
SBM	synthetic-based muds
SCAT	Shoreline Cleanup and Assessment Team
Secretary	Secretary of the Interior
SEMS	Safety and Environmental Management System
SO_2	sulphur dioxide
SO_x	sulphur oxides
sp.	species
spp.	multiple species
Stat.	Statute
STOF-THPO	Seminole Tribe of Florida-Tribal Historic Preservation Officer
TA&R	Technology Assessment & Research Program

Tcf	trillion cubic feet
TGLO	Texas General Land Office
TX	Texas
U.S.	United States
U.S.C.	United States Code
UIC	Unified Incident Command
UME	unusual mortality event
USCG	U.S. Coast Guard (also: CG)
USDHS	U.S. Department of Homeland Security
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOE	U.S. Department of the Energy (also: DOE)
USDOI	U.S. Department of the Interior (also: DOI)
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey (also: GS)
VOC	volatile organic compounds
VSP	vertical seismic profiling
W.	west
WAF	water accommodated fraction
WBF	water-based fluids
WPA	Western Planning Area
WSF	water soluble fraction
yd	yard
yr	year

CONVERSION CHART

To convert from	To	Multiply by
millimeter (mm)	inch (in)	0.03937
centimeter (cm)	inch (in)	0.3937
meter (m)	foot (ft)	3.281
kilometer (km)	mile (mi)	0.6214
meter^2 (m^2)	foot^2 (ft^2)	10.76
	yard^2 (yd^2)	1.196
	acre (ac)	0.0002471
hectare (ha)	acre (ac)	2.47
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
meter^3 (m^3)	foot^3 (ft^3)	35.31
	yard^3 (yd^3)	1.308
liter (l)	gallons (gal)	0.2642
degree Celsius (°C)	degree Fahrenheit (°F)	°F = (1.8 x °C) + 32

1 barrel (bbl) = 42 gal = 158.9 l = approximately 0.1428 metric tons
tonnes = 1 long ton or 2,200 lb
1 nautical mile (nmi) = 6,076 ft or 1.15 mi

CHAPTER 1

THE PROPOSED ACTIONS

1. THE PROPOSED ACTIONS

1.1. Purpose of and Need for the Proposed Actions

The proposed Federal actions addressed in this environmental impact statement (EIS) are 10 areawide oil and gas lease sales, 5 each in the Western Planning Area (WPA) and Central Planning Area (CPA) of the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) (**Figure 1-1**). Under the *Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017* (5-Year Program), two sales would be held each year—one in the WPA and one in the CPA (**Table 1-1**). The first two proposed lease sales are WPA Lease Sale 229 scheduled for 2012 and CPA Lease Sale 227 scheduled for 2013. The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources. The proposed lease sales will provide qualified bidders the opportunity to bid upon and lease acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas. This EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. 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. An additional NEPA review will be conducted for each subsequent proposed lease sale in the 5-Year Program.

The need for the proposed actions 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. Oil from the WPA and CPA would help reduce the Nation's need for oil imports and lessen a growing dependence on foreign oil. The United States (U.S.) consumed 18.7 million barrels (MMbbl) of oil per day in 2009 (USDOE, Energy Information Administration, 2010a). Altogether, net imports of crude oil and petroleum products (imports minus exports) accounted for 51 percent of our total petroleum consumption in 2009. The U.S. crude oil imports stood at 9.0 MMbbl per day in 2009. Petroleum product imports were 2.7 MMbbl per day in 2009. Exports totaled 2.0 MMbbl per day in 2009, mainly in the form of distillate fuel oil, petroleum coke, and residual fuel oil. Our biggest supplier of crude oil and petroleum-product imports was Canada (21.2%), with countries in the Persian Gulf being the second largest source (17%) in 2009 (USDOE, Energy Information Administration, 2010b). Oil produced from the WPA and CPA would also reduce the environmental risks associated with transoceanic oil tankering from sources overseas.

In 2009, the U.S. consumed approximately 22.8 trillion cubic feet (Tcf) of natural gas from all sources (USDOE, Energy Information Administration, 2011a). In 2009, the Gulf Coast States used approximately 6.4 Tcf of natural gas (USDOE, Energy Information Administration, 2011a). In 2008, 11.7 percent of U.S. natural gas resources were imported, mostly from Canada (USDOE, Energy Information Administration, 2010c). In 2009, 88 percent of net imports came by pipeline, primarily from Canada, and 12 percent came by liquefied natural gas (LNG) tankers carrying gas from five different countries (USDOE, Energy Information Administration, 2010d). Natural gas is generally considered to be an environmentally preferable alternative to oil, especially when used to generate electricity or for residential and industrial heating. Natural gas is an important feedstock for domestic industries engaged in the manufacture or formulation of fertilizers, pharmaceuticals, plastics, and packaging.

The Outer Continental Shelf Lands Act (OCSLA) of 1953 (67 Stat. 462), as amended (43 U.S.C. 1331 *et seq*. [1988]), established Federal jurisdiction over submerged lands on the OCS seaward of the State boundaries. Under the OCSLA, the Department of the Interior (DOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary of the Interior (Secretary) oversees the OCS oil and gas program and is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained. The Act empowers the Secretary to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the Act.

The Secretary has designated the Bureau of Ocean Energy Management (BOEM) as the administrative agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after lease issuance. Effective October 1, 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) was reorganized and separated into two separate bureaus, the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). The BOEM is responsible for managing development of the Nation's offshore resources in an environmentally and economically responsible way. The functions of BOEM include leasing, exploration and development, plan administration, environmental studies, NEPA analysis, resource evaluation, economic analysis, and the renewable energy program. The BSEE is responsible for enforcing safety and environmental regulations. The functions of BSEE include all field operations, including permitting and research, inspections, offshore regulatory programs, oil-spill response, and training and environmental compliance functions.

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 crude oil and natural gas for more than 50 years. Oil from the GOM can help reduce the Nation's need for oil imports and reduce the environmental risks associated with oil tankering. Natural gas is generally considered to be an environmentally preferable alternative to oil, both in terms of the production and consumption.

1.2. DESCRIPTION OF THE PROPOSED ACTIONS

The proposed actions are 10 oil and gas lease sales, 5 each in the WPA and CPA as scheduled under the proposed 5-Year Program. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since the proposed lease sales in each lease sale area and their projected activities are very similar, BOEM has decided to prepare a single EIS for the WPA and CPA lease sales in the proposed 5-Year Program.

Proposed WPA Lease Sales 229, 233, 238, 246, and 248

The first proposed WPA lease sale is Sale 229, scheduled to be held in 2012. The WPA sale area encompasses virtually all of the WPA's 28.58 million acres (ac) and is located 3 leagues (10 miles [mi]) offshore Texas and extends seaward to the limits of the Economic Exclusion Zone in water depths up to 3,346 meters (m) (10,978 ft) (**Figure 1-1**). As of November 2011, about 21.2 million ac of the WPA sale area are currently unleased. Each WPA proposed lease sale would offer for lease all unleased blocks in the WPA for oil and gas operations (**Figure 1-1**), with the following exceptions:

(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 nmi north of the continental shelf boundary between the U.S. and Mexico.

The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.116-0.200 billion barrels of oil (BBO) and 0.538-0.938 Tcf of gas. The proposed WPA lease sales include proposed lease stipulations designed to reduce environmental risks, which are discussed in **Chapter 2.3.1.3**

Proposed CPA Lease Sales 227, 231, 235, 241, and 247

The first proposed CPA lease sale is 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 is located offshore Louisiana, Mississippi, and Alabama from 3 to about 230 nmi (3.5 to 265 mi; 5.6 to 426 km) offshore in water depths of about 3 to >3,400 m (9 to >11,115 ft) (**Figure 1-1**). As of November 2011, about 38.6 million ac of the CPA sale area are currently unleased. Each proposed CPA sale would offer for lease all unleased blocks in the CPA for oil and gas operations (**Figure 1-1**), with the following exceptions:

(1) blocks that were previously included within the Eastern Planning Area (EPA) and that are within 100 mi (161 km) of the Florida coast;

(2) blocks east of the Military Mission line (86 degrees, 41 minutes west longitude) under an existing moratorium 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 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. The proposed CPA lease sales include proposed lease stipulations designed to reduce environmental risks, which are discussed in **Chapter 2.4.1.3**.

1.3. REGULATORY FRAMEWORK

Federal laws mandate the OCS leasing program (i.e., Outer Continental Shelf Lands Act) and the environmental review process (i.e., National Environmental Policy Act). Several Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies (i.e., Coastal Zone Management Act, Endangered Species Act, the Magnuson Fishery Conservation and Management Act, and the Marine Mammal Protection Act). In addition, the OCS leasing process and all activities and operations on the OCS must comply with other applicable Federal, State, and local laws and regulations. On December 20, 2006, President Bush signed into law the Gulf of Mexico Energy Security Act of 2006 (GOMESA), which made available two new areas in the GOM for leasing, placed a moratorium on other areas in the GOM, and increased the distribution of offshore oil and gas revenues to coastal States. The following major, applicable Federal laws, regulations, and Executive Orders are summarized in *OCS Regulatory Framework for the Gulf of Mexico Region* (Matthews and Cameron, 2010).

Regulation, Law, and Executive Order	Citation
Outer Continental Shelf Lands Act	43 U.S.C. 1331 *et seq*.
National Environmental Policy Act of 1969	42 U.S.C. 4321-4347 40 CFR 1500-1508
Coastal Zone Management Act of 1972	16 U.S.C. 1451 *et seq*. and 15 CFR 930.76
Endangered Species Act of 1973	16 U.S.C. 1631 *et seq*.
Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. 1251 *et seq*.
Essential Fish Habitat	1996 reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat Consultation	50 CFR 600.90-30
Marine Mammal Protection Act	16 U.S.C. 1361 *et seq*.
Clean Air Act	42 U.S.C. 7401 *et seq*. 40 CFR 55
Clean Water Act	Amendment to Federal Water Pollution Control Act of 1972
Clean Water Act—National Pollutant Discharge Elimination System	Section 316(b) of the Clean Water Act
Harmful Algal Bloom and Hypoxia Research and Control Act	P.L. 105-383
Oil Pollution Act of 1990	33 U.S.C. 2701 *et seq*. Executive Order 12777

Comprehensive Environmental Response, Compensation, and Liability Act of 1980	42 U.S.C. 9601 *et seq*.
Resource Conservation and Recovery Act	42 U.S.C. 6901 *et seq*.
Marine Plastic Pollution Research and Control Act	33 U.S.C. 1901 *et seq*.
National Fishing Enhancement Act of 1984	33 U.S.C. 2601 *et seq*.
Fishermen's Contingency Fund	43 U.S.C. 1841-1846.
Ports and Waterways Safety Act of 1972	33 U.S.C. 1223 *et seq*.
Marine and Estuarine Protection Acts	33 U.S.C. 1401 *et seq*.
Marine Protection, Research, and Sanctuaries Act of 1972	P.L. 92-532
National Estuarine Research Reserves	16 U.S.C. 1461, Section 315
National Estuary Program	P.L. 104-4
Coastal Barrier Resources Act	16 U.S.C. 3501 *et seq*.
National Historic Preservation Act	16 U.S.C. 470 *et seq*.
Rivers and Harbors Act of 1899	33 U.S.C. 401 *et seq*.
Occupational Safety and Health Act of 1970	29 U.S.C. 651-678 *et seq.*
Energy Policy Act of 2005	P.L. 109-58
Gulf of Mexico Energy Security Act of 2006	P.L. 109-432
Marine Debris Research, Prevention, and Reduction Act	P.L. 109-449
American Indian Religious Freedom Act of 1978	Public Law 95-341 42 U.S.C. 1996 and 1996a
Federal Aviation Act of 1958	Federal Aviation Act of 1958 was repealed by the recodification of Title 49, United States Code (P.L. 103-272)
Migratory Bird Treaty Act of 1918	16 U.S.C. 703-712; Ch. 128; 7/13/1918; 40 Stat. 755
Submerged Lands Act of 1953	43 U.S.C. §§ 1301-1315 (2002)
49 U.S.C. 44718: Structures Interfering with Air Commerce	49 U.S.C. 44718
U.S. Coast Guard Regulations	
Marking of Obstructions	
Executive Order 11988: Floodplain Management	42 FR 26951 (1977); Amended by Executive Order 12148 (7/20/79)
Executive Order 11990: Protection of Wetlands	42 FR 26961 (1977); Amended by Executive Order 12608 (9/9/87)
Executive Order 12114: Environmental Effects Abroad	44 FR 1957 (1979)
Executive Order 12898: Environmental Justice	59 FR 5517 (1994)
Executive Order 13007: Indian Sacred Sites	61 FR 26771-26772 (1996)
Executive Order 13089: Coral Reef Protection	63 FR 32701-32703 (1998)
Executive Order 13175: Consultation and Coordination with Indian Tribal Governments	65 FR 67249-67252 (2000)
Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds	66 FR 3853 (2001)

1.3.1. Rule Changes Resulting from the *Deepwater Horizon* Event

On April 20, 2010, the *Deepwater Horizon* (DWH) mobile offshore drilling unit (MODU) exploded at approximately 9:48 p.m. CDT and began to burn uncontrollably. Between April 20 and July 15, 2010, oil flowed from the Macondo well in Mississippi Canyon Block 252 (**Figure 1-2)**. In the aftermath of the DWH event on April 20, 2010, President Obama directed the Secretary of the Interior to report within 30 days on what, if any, additional precautions, technologies, and procedures should be required on the OCS to improve the safety of oil and gas development. In response to this directive, the Department of the Interior prepared the report, *Increased Safety Measures for Energy Development on the Outer Continental Shelf*. The "30-Day Report" or "Safety Measures Report" was delivered to the Secretary and made public on May 27, 2010 (USDOI, 2010a).

On a separate track and beginning long before the DWH event, this Agency published an Advanced Notice of Proposed Rulemaking (ANPR) (*Federal Register*, 2006a) on May 22, 2006, to solicit ideas for adoption of the American Petroleum Institute (API) Recommended Practice (RP) 75 for development of a Safety and Environmental Management System (SEMS) for OCS operations and facilities (API, 2004). This Agency published a Notice of Proposed Rulemaking (NPR) on June 17, 2009 (*Federal Register*, 2009a), based on comments received on the 2006 ANPR. This Agency was in the process of finalizing the rule when the DWH event (Macondo spill) took place. The final rule (*Federal Register*, 2010a) was published on October 15, 2010, requiring full implementation of a SEMS program as recommended by API RP 75.

On May 28, 2010, the Secretary directed this Agency to exercise its authority under the OCSLA to suspend certain drilling activities in water depths of 500 ft (152 m) and deeper for a period of up to 6 months. The May 28th suspension was intended to provide sufficient time to (1) ensure that drilling operations in conditions similar to those associated with the DWH event proceed in a safe manner when drilling resumes, (2) account for the expected timeline for killing the Macondo well so that the extensive spill response resources directed toward the spill would be available in the event of other spill events, and (3) provide adequate time to obtain input from ongoing investigations of the accident and to develop and promulgate regulations that address issues described in the Safety Measures Report.

On June 22, 2010, the United States Federal District Court in the Eastern District of Louisiana enjoined enforcement of the May 28th suspension. On July 12, 2010, the Secretary issued a decision memorandum rescinding the May 28th suspension and imposing a second suspension of certain drilling operations in deep water. This suspension was originally announced to be effective until November 30, 2010. The July 12th suspension applied, with certain exceptions, to the drilling of wells using a subsea blowout preventer (BOP) or a surface BOP on a floating facility. Three primary issues supported this temporary pause in drilling operations. The suspension (1) allowed time for BOEMRE to implement appropriate workplace and drilling safety measures; (2) was intended to provide BOEMRE, the industry, and others time to develop strategies and methods of containment of wild wells in deep water; and (3) was necessary to ensure that appropriate and sufficient response resources would be available in the event of another major oil spill.

The BOEMRE reduced the duration of the July 12, 2010, suspension and wrote an environmental assessment with a Finding of No Significant Impact related to the early lifting of the suspension (USDOI, BOEMRE, 2010a). On October 12, 2010, the July 12th suspension was lifted in its entirety. After October 12, 2010, BOEMRE began to review and approve pending and future applications for permits to drill deepwater development wells using a subsea BOP or a surface BOP on a floating facility. Operators are still required to complete the documentation required to certify to BOEM that they are ready to reinitiate their projects in compliance with any applicable new regulations or procedures.

The Interim Final Rule to Enhance Safety Measures for Energy Development on the Outer Continental Shelf ("Drilling Safety Rule") (*Federal Register*, 2010b) identifies those regulatory changes made as a result of the "30-Day Report" (**Table 1-2**). All of the provisions of the Drilling Safety Rule are implemented by BSEE. As of this writing, all regulatory citations in this EIS are concordant with the regulation changes made following the effective date of October 1, 2011, for the creation of the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement (*Federal Register*, 2011a). These regulations, the NTL's indicated below, and the procedures were not in effect at the time of the DWH event, but they will apply to all future applicable drilling activities. The regulations, NTL's, and procedures include the following:

- NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," effective June 18, 2010 ("Plans NTL").
- NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," effective November 8, 2010 ("Certification NTL").
- The Drilling Safety Rule, Interim Final Rule to Enhance Safety Measures for Energy Development on the Outer Continental Shelf ("Drilling Safety Rule") (*Federal Register*, 2010b). This rule strengthens requirements for safety equipment, well control systems, and blowout prevention practices on offshore oil and gas operations.
- The Workplace Safety Rule on Safety and Environmental Management Systems ("SEMS Rule") (*Federal Register*, 2010a). This rule requires operators to develop and implement a comprehensive SEMS for identifying, addressing, and managing operational safety hazards and impacts; promoting both human safety and environmental protection; and improving workplace safety by reducing the risk of human error.
- Enhanced Inspection Procedures. The BSEE is developing plans and schedules for conducting safety inspections of all deepwater drilling facilities. These plans and schedules have been implemented.

The BOEMRE determined issuance of an interim rule was needed; this rule implements the recommendations from the 30-Day Report considered by the Secretary to be the most important for safe resumption of offshore drilling operations. On October 14, 2010, the interim final rule was published in the *Federal Register* (2010b), together with a discussion of the comments that had been received by the Secretary in the period leading up to promulgation of the rule. The interim rulemaking revises selected sections of 30 CFR 250 Subparts D, E, F, O, and Q. Only a portion of the proposed changes in Subpart D add material capital or operating costs (some of which may be significant). For example, identical costly new requirements for subsea function testing of remotely operated vehicle (ROV) intervention during drill operations (Subpart D) apply to well completion (Subpart E) and workover (Subpart F) operations.

Table 1-2 compares the previous 30 CFR 250 Subpart D requirements with the new regulations. Those changes that impose significant costs include (1) seafloor function testing of ROV intervention and deadman systems (30 CFR 250.449(j) and (k), 30 CFR 250.516(d) and 250.616(h)); (2) negative pressure testing of individual casing strings (30 CFR 250.423(c)); (3) use of dual mechanical barriers for the final casing string (30 CFR 250.420(b)); (4) professional engineer certification that the well design is appropriate for expected wellbore conditions (30 CFR 250.420(a)); (5) retrieval and testing of BOP after a shear ram has been activated in a well-control situation (30 CFR 250.451(i)); and (6) third-party certification that the shear rams will shear drill pipe under maximum anticipated pressure (30 CFR 250.416(e)).

Subsea ROV and Deadman Function Testing—Drilling

Previous regulations at 30 CFR 250.449(b) required a stump test of the subsea BOP system. In a stump test, the subsea BOP system is placed on a simulated wellhead (the stump) on the rig floor. The BOP system is tested on the stump to ensure that the BOP is functioning properly. The new regulatory section at 30 CFR 250.449(j) requires that all ROV intervention functions on the subsea BOP stack must be tested during the stump test and that one set of rams must be tested by an ROV on the seafloor.

Autoshear and deadman control systems activate during an accidental disconnect or loss of power, respectively. The new regulatory section at 30 CFR 250.449(k) requires that the autoshear and deadman systems be function-tested during the stump test, and the deadman system tested during the initial test on the seafloor. The initial test on the seafloor is performed as soon as the BOP is attached to the subsea wellhead.

These new requirements confirm that a well will be secured in an emergency situation and prevent a possible loss of well control. The ROV test requirement ensures that the dedicated ROV has the capacity to close the BOP functions on the seafloor. The deadman-switch test on the seafloor verifies that the wellbore closes automatically if both hydraulic pressure and electrical communication are lost with the rig.

The initial test on the seafloor for one set of rams and the deadman system is not currently an industry standard practice and will incur lost rig time. The addition of autoshear and deadman systems stump testing incur additional lost rig time, but BSEE does not expect the ROV intervention function stump testing to significantly increase testing time. Some operators currently simulate the hydraulic flow of an ROV to function test the BOP stack, while others use an actual ROV to test the BOP stack; this regulation requires the use of an ROV during the stump test.

The BOEMRE conducted a survey to investigate the potential impact of subsea ROV testing. Several drilling contractors, lease operators, and equipment manufacturers were asked: "How long would it take to function test the ROV to verify that the ROV could be used to close one set of blind-shear rams, one set of pipe rams, and disconnect the lower marine riser package (LMRP)?" Results averaged about 24 hours of lost rig time to perform these subsea tests. However, the interim regulation only requires one set of rams and the deadman system to be tested on the seafloor, without disconnecting the LMRP. The LMRP disconnect is estimated to require more time than testing the deadman system alone. The BSEE did not ask about the autoshear and deadman stump test requirements in our survey. The BSEE estimated that performing both the autoshear and deadman stump tests would take close to the same time required to test the LMRP seafloor disconnect. The regulation does not affect fixed platform rigs or shallow wells since they do not use subsea BOP's or ROV's.

Subsea ROV Function Testing—Workover/Completions

Previous regulations did not require subsea ROV function testing of the BOP during workover or completions operations. The new regulatory sections 30 CFR 250.516(d)(8) and 250.616(h)(1) require testing of ROV intervention functions and the autoshear/deadman systems during the stump test, and a function test of at least one set of rams and the deadman system on the seafloor. These sections extend the requirements added to deepwater drilling operations (discussed in the previous section) to well completion operations and workover operations using a subsea BOP stack. Successful exploratory wells are typically temporarily abandoned until additional equipment is built and installed to produce the reservoir. When the operator is preparing to produce the well, it is often completed using a different rig or redeployment of the original rig. The BSEE data show that two-thirds of deepwater wells drilled are exploratory wells, and approximately 23 percent of exploratory wells are completed.

Negative Pressure Tests

Previous regulation at 30 CFR 250.423 required a positive pressure test for each string of casing, except for the drive or structural casing string. This test confirms that fluid from the casing string is not flowing into the formation. The new regulatory section at 30 CFR 250.423(c) requires that a negative pressure test be conducted for all intermediate and production casing strings. This test will reveal whether gas or fluid from outside the casing is flowing into the well and ensures that the casing and cement provide a seal. Maintenance of pressure under both tests ensures proper casing installation and the integrity of the casing and cement. Based on in-house expertise, BSEE estimates each new negative pressure test will take approximately 90 minutes for each casing string. The BSEE also estimates that, on average, deepwater wells use one production and four intermediate casing strings and that shallow wells use one production and two intermediate casing strings.

Installation of Dual Mechanical Barriers

Previous regulations did not require the installation of dual mechanical barriers. The new regulatory section at 30 CFR 250.420(b)(3) requires the operator install dual mechanical barriers in addition to cement barriers for the final casing string. These barriers prevent hydrocarbon flow in the event of cement failure at the bottom of the well. The operator must document the installation of the dual mechanical barriers and submit this documentation to BOEM within 30 days after installation. These new requirements ensure that the best casing and cementing design will be used for a specific well. Dual mechanical barriers may include two float valves or one float valve and one mechanical plug. Based on in-house expertise, BOEM estimates that all wells will require a second mechanical barrier.

Professional Engineer Certification for Well Design

Previous regulations at 30 CFR 250.420(a) specified well casing and cementing requirements but did not require verification by a Registered Professional Engineer. The new regulatory section at 30 CFR 250.420(a)(6) requires that well casing and cementing specifications must be certified by a Registered Professional Engineer. The Registered Professional Engineer will verify that the well casing and cementing design is appropriate for the purpose for which it is intended under expected wellbore conditions. This verification adds assurance that the appropriate design is used for the well, thus decreasing the likelihood of a blowout.

Emergency Cost of Activated Shear Rams

Previous regulations did not address BOP inspection following use of the blind-shear ram or casing shear ram. The new regulatory section at 30 CFR 250.451(i) requires that, if a blind-shear ram or casing shear ram is activated in a well control situation where the pipe is sheared, the BOP stack must be retrieved, fully inspected, and tested. This provision ensures the integrity of the BOP and that the BOP will still function and hold pressure after the event. This activity, when triggered, will add about 13 days to drilling time. According to a Det Norske Veritas study, out of 5,611 deepwater wells, there were 12 situations where either the blind-shear or casing shear ram was activated; this implies one activation for every 515 wells drilled (Det Norske Veritas, 2010).

Third-Party Shearing Verification

Regulation 30 CFR 250.416(e) requires information verifying that BOP blind-shear rams are capable of cutting through any drill pipe in the hole under maximum anticipated conditions. This regulation has been modified to require the BOP verification be conducted by an independent third party. The independent third party provides an objective assessment that the blind-shear rams can shear any drill pipe in the hole if the shear rams are functioning properly. This confirmation will be required for both subsea and surface BOP's. The NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," clarifies how the regulations apply to operators conducting operations using subsea BOP's or surface BOP's on floating facilities. The NTL informs these operators that a statement, signed by an authorized company official stating that the operator will conduct all authorized activities in compliance with all applicable regulations, including the increased safety measures regulations, should be submitted with each application for a well permit.

30 CFR 250 Subpart S—Safety and Environmental Management System (SEMS)

Following the DWH event, BOEMRE promulgated a final rule that requires operators to develop and implement a SEMS for OCS operations (*Federal Register*, 2010a). As explained in a BOEMRE fact sheet (USDOI, BOEMRE, 2010b), a SEMS is a comprehensive management program for identifying, addressing, and managing operational safety hazards and impacts, with the goal of promoting both human safety and environmental protection. The SEMS program rule is a workplace safety program rule covering all offshore oil and gas operations in Federal waters, and it makes mandatory the previously voluntary practices in the API RP 75. A mandatory oil and gas SEMS program is intended to enhance the safety and environmental protection of oil and gas drilling operations on the OCS. The SEMS Rule is implemented in the new Subpart S of 30 CFR 250.1900-1915. The Final Rule became effective on November 15, 2010, and it must be implemented by November 15, 2011.

This Agency was preparing to finalize the SEMS Workplace Safety Rule before the DWH event. During the DWH event, BOEMRE continued to carefully analyze the proposed rule, which proposed making mandatory the essential components of API RP 75. The BOEMRE determined it was appropriate to incorporate all of API RP 75. The BOEMRE intends to address additional safety management system provisions considered appropriate in light of the DWH event in additional future rulemakings.

Implementation of the Workplace Safety Rule has the following benefits: (1) it will provide oversight and enforcement of SEMS provisions (Although many large operators on the OCS currently have a SEMS program, the voluntary nature of the program limits its effectiveness, and smaller operators may be less familiar with the concepts.); (2) it will impose the requirement for a SEMS program on all OCS operators; (3) it will address human factors behind accidents not reached by previous regulations; and (4) it will provide a flexible approach to systematic safety that can keep up with evolving technologies.

The 13 elements of API RP 75 that 30 CFR 250 Subpart S now make mandatory are as follows:

- defining the general provisions for implementation, planning and management review, and approval of the SEMS program;
- identifying safety and environmental information needed for any facility (such as design data), facility process (such as flow diagrams), and mechanical components (such as piping and instrument diagrams);
- requiring a facility-level risk assessment;
- addressing any facility or operational changes including management changes, shift changes, contractor changes;
- evaluating operations and written procedures;
- specifying safe work practices, manuals, standards, and rules of conduct;
- training, safe work practices, and technical training, including for contractors;
- defining preventive maintenance programs and quality control requirements;
- requiring a pre-startup review of all systems;
- responding to and controlling emergencies, evacuation planning, and oil-spill contingency plans in place and validated by drills;
- investigating incidents, procedures, corrective action, and follow-up;
- requiring audits every 4 years, to an initial 2-year reevaluation and then subsequent 3-year audit intervals; and
- specifying records and documentation that describe all elements of the SEMS program.

1.3.2. Rule Changes for the Reorganization of Title 30 for the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement

As of this writing, all regulatory citations in this EIS are concordant with the regulation changes made following the effective date of October 1, 2011, for the creation of the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement (*Federal Register*, 2011a).

On May 19 2010, U.S. Dept. of the Interior Secretary Salazar announced in Secretarial Order 3299 (USDOI, 2010b) that the Bureau of Ocean Energy Management, Regulation and Enforcement would be reorganized into two new bureaus within DOI and that each bureau would be reporting to the Assistant Secretary Land and Minerals Management. These bureaus are now known as the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). The mission of these new bureaus was announced by the Secretary (USDOI, 2010b). The BOEM is responsible for managing development of the Nation's offshore resources in an environmentally and economically responsible way. The functions of BOEM include leasing, exploration and development, plan administration, environmental studies, NEPA analysis, resource evaluation, economic analysis, and the renewable energy program. The BSEE is responsible for enforcing safety and environmental regulations. The functions of BSEE include all field operations, including permitting and research, inspections, offshore regulatory programs, oil-spill response, and training and environmental compliance functions.

After the new organizations were announced by the Secretary on June 18, 2010 (USDOI, 2010c), the Secretary issued Secretarial Order 3302 that, for the interim, announced the name change of the former Minerals Management Service (MMS) to the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). In the period between June 18, 2010, and October 1, 2011, BOEMRE planned the reorganization and the separation of responsibilities for the regulations under Title 30, "Minerals Resources," that had pertained to the former MMS. Regulations that are to be administered by BSEE remain in Title 30 CFR Chapter II under this Agency's name, and the regulations that are to be administered by BOEM were moved into a new Title 30 CFR Chapter V under this Agency's name (30 CFR 250). An announcement (*Federal Register*, 2011a) promulgated a new rule that mapped the Title 30 regulations that will be under the authority of the two newly formed bureaus among those now existing. The rule pertained solely to the organization and codification of existing rules and related technical changes necessitated by a division of one bureau into two separate bureaus. The rule made no changes to the substantive legal rights, obligations, or interests of affected parties; therefore, it had no public comment period. A summary breakdown of responsibility for the regulations under Title 30 is provided in **Table 1-3**. A future proposed rulemaking is planned for joint issue by BOEM and BSEE to address regulatory anomalies created by splitting the functions of one bureau into two, and there will be a public comment period before finalization.

1.4. PRELEASE PROCESS

Scoping for this EIS was conducted in accordance with Council on Environmental Quality (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 Notice of Intent to Prepare an EIS (NOI) and Scoping Meetings 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. Formal scoping meetings were held during February 2011 in Texas, Louisiana, and Alabama. Comments were received in response to the NOI and at the three scoping meetings from Federal, State, and local government 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 mitigation measures. All scoping comments received were considered in the preparation of the Draft EIS. The comments (both verbal and written) have been summarized in **Chapter 5.3**, "Development of the Draft EIS."

The BOEM also 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 this EIS. Key agencies and organizations included the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), U.S. Department of Defense (USDOD or DOD), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), State governors' offices, and industry groups.

Although the scoping process was formally initiated on February 9, 2011, with the publication of the NOI in the *Federal Register*, scoping efforts and other coordination meetings have proceeded and will continue to proceed throughout this NEPA process. Scoping and coordination opportunities are available during BOEM's requests for information, comments, input, and review on other Bureau of Ocean Energy Management NEPA documents.

On June 20, 2011, the Area Identification (Area ID) decision was made. One Area ID was prepared for all proposed lease sales. The Area ID is an administrative prelease step that describes the geographical area of the proposed actions (proposed lease sale areas) and identifies the alternatives, mitigating measures, and issues to be analyzed in the appropriate NEPA document. As mandated by NEPA, this EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments.

The BOEM will send copies of the Draft EIS for review and comment to public and private agencies, interest groups, and local libraries. To initiate the public review and comment period on the Draft EIS, BOEM will publish a Notice of Availability (NOA) in the *Federal Register*. Additionally, public notices will be mailed with the Draft EIS and placed on the BOEM Internet website (http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx). In accordance with 30 CFR 556.26, BOEM will hold public hearings to solicit comments on the Draft EIS. The hearings provide the Secretary with information from interested parties to help in the evaluation of potential effects of the proposed lease sales. Notices of the public hearings will be included in the NOA, posted on the BOEM Internet website, and published in the *Federal Register* and local newspapers.

A consistency review will be performed and a Consistency Determination (CD) will be prepared for each affected State prior to each proposed lease sale. To prepare the CD's, BOEM reviews each State's Coastal Management Program (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. 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 (NOS). If a State disagrees with the Bureau of Ocean Energy Management's CD, the State is required to do the following under CZMA: (1) indicate how the BOEM presale proposal is inconsistent with its CMP; (2) suggest alternative measures to bring the BOEM proposal into consistency with their CMP; or (3) 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 not a procedure for administrative appeal to the Secretary of Commerce for a Federal CD for presale activities. In the event of a disagreement between a Federal agency and the State CMP regarding consistency of the proposed lease sale, either BOEM or the State may request mediation. The regulations provide for an opportunity to resolve any differences with the State, but CZMA allows BOEM to proceed with the lease sale despite any unresolved disagreements if the Federal Agency clearly describes, in writing, to the State CMP how the activity is consistent to the maximum extent practicable.

The Final EIS will be published approximately 5 months prior to the first proposed sale, WPA Lease Sale 229, which is scheduled for November 2012. To initiate the public review and 30-day minimum comment period on the Final EIS, BOEM will publish a NOA in the *Federal Register*. The BOEM will send copies of the Final EIS for review and comment to public and private agencies, interest groups, and local libraries. Additionally, public notices will be mailed with the Final EIS and placed on the BOEM Internet website (http://www.boem.gov/).

After the end of the comment period, DOI will review the EIS and all comments received on the Final EIS. The EIS is not a decision document. A Record of Decision (ROD), which is the last step in this EIS process, will identify the alternative chosen. The ROD will summarize the proposed actions and the alternatives evaluated in the EIS, the conclusions of the impact analyses, and other information considered in reaching the decision. All comments received on the Final EIS will be addressed in the ROD.

A Proposed NOS will become available to the public 4-5 months prior to a proposed lease sale. A notice announcing the availability of the Proposed NOS appears in the *Federal Register* initiating a 60 day comment period. Comments received will be analyzed during preparation of the decision documents that are the basis for the Final NOS, including lease sale configuration and terms and conditions.

If the decision by the Assistant Secretary of the Interior for Land and Minerals (ASLM) is to hold a proposed sale, a Final NOS will be published in its entirety in the *Federal Register* at least 30 days prior to the sale date, as required by the OCS Lands Act.

1.5. Postlease Activities

The BOEM is responsible for managing, regulating, and monitoring oil and natural gas exploration, development, and production operations on the Federal OCS to promote orderly development of mineral resources and to prevent harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations for oil, gas, and sulphur lease operations are specified in 30 CFR 550, 30 CFR 551(except those aspects that pertain to drilling), and 30 CFR 554.

Measures to minimize potential impacts are an integral part of the OCS Program. These measures are implemented through lease stipulations, operating regulations, NTL's, and project-specific requirements or approval conditions. These measures address concerns such as endangered and threatened species, geologic and manmade hazards, military warning and ordnance disposal areas, archaeological sites, air quality, oil-spill response planning, chemosynthetic communities, artificial reefs, operations in hydrogen sulfide (H_2S) prone areas, and shunting of drill effluents in the vicinity of biologically sensitive features. Standard mitigation measures in the Gulf of Mexico OCS include

- limiting the size of explosive charges used for structure removals;
- requiring placement of explosive charges at least 15 ft (5 m) below the mudline;
- requiring site-clearance procedures to eliminate potential snags to commercial fishing nets;
- establishment of No Activity and Modified Activity Zones around high-relief live bottoms;
- requiring remote-sensing surveys to detect and avoid potential archaeological sites and biologically sensitive areas such as low-relief live bottoms, pinnacles, and chemosynthetic communities; and
- requiring coordination with the military to prevent multiuse conflicts between OCS and military activities.

The BOEM issues NTL's to provide clarification, description, or interpretation of a regulation; guidelines on the implementation of a special lease stipulation or regional requirement; or convey administrative information. A detailed listing of current Gulf of Mexico OCS Region NTL's is available through the BOEM, Gulf of Mexico OCS Region's Internet website or through the Region's Public Information Office at (504) 736-2519 or 1-800-200-GULF.

Formal plans must be submitted to BOEM for review and approval before any project-specific activities, except for ancillary activities (such as geological and geophysical activities or studies that model potential oil and hazardous substance spills), can begin on a lease. Conditions of approval are mechanisms to control or mitigate potential safety or environmental problems associated with proposed operations. Conditions of approval are based on BOEM technical and environmental evaluations of the proposed operations. Comments from Federal and State agencies (as applicable) are also considered in establishing conditions. Conditions may be applied to any OCS plan, permit, right-of-use of easement, or pipeline right-of-way grant.

Some BOEM-identified mitigation measures are implemented through cooperative agreements or coordination with the oil and gas industry and Federal and State agencies. These measures include NMFS's Observer Program to protect marine mammals and sea turtles when OCS structures are removed using explosives, labeling of operational supplies to track sources of accidental debris loss, development of methods of pipeline landfall to eliminate impacts to barrier beaches, and semiannual beach cleanup events.

The following postlease activity descriptions apply to the proposed lease sale area in the WPA and CPA.

Geological and Geophysical Activities

A geological and geophysical (G&G) permit must be obtained from BOEM prior to conducting off-lease geological or geophysical exploration or scientific research on unleased OCS lands or on lands under lease to a third party (30 CFR 251.4 (a) and (b)). Geological investigations include various seafloor sampling techniques to determine the geochemical, geotechnical, or engineering properties of the sediments.

Ancillary activities are defined in 30 CFR 550.105 with regulations outlined in 30 CFR 550.207 through 550.210. Ancillary activities are activities conducted on-lease and include G&G exploration and development G&G activities; geological and high-resolution geophysical, geotechnical, archaeological, biological, physical oceanographic, meteorological, socioeconomic, or other surveys; or various types of modeling studies. This Agency issued NTL 2009-G34, "Ancillary Activities," to provide updated guidance and clarification on conducting ancillary activities in BOEM's Gulf of Mexico OCS Region. Operators should notify the Gulf of Mexico OCS Region, Regional Supervisor, Regional Field Operations, in writing 30 days in advance before conducting any of the following types of ancillary activities related to a G&G exploration or development G&G activity:

- involving the use of an airgun or airgun array in water depths 200 m (656 ft) or greater, or in the Eastern Planning Area (EPA) of the GOM in any water depth;
- independent of water depth, involving the use of explosives as an energy source; and
- independent of water depth, including ocean-bottom cable surveys, node surveys, and time-lapse (4D) surveys.

Additionally, NTL 2009-G34 clarifies that the Gulf of Mexico OCS Region, Regional Supervisor, Field Operations, should be notified in writing 15 days in advance before conducting the following types of other ancillary activities:

- involving the use of an airgun or airgun array in water depths 200 m (656 ft) or greater, or in the EPA of the GOM in any water depth;
- involving bottom disturbance, independent of water depth, including ocean-bottom cable surveys, node surveys, and time-lapse (4D) surveys; and
- a geotechnical evaluation involving piston-/gravity-coring or the recovery of sediment specimens by grab-sampling or similar technique and/or any dredging or other ancillary activity that disturbs the seafloor (including deployment and retrieval of bottom cables, anchors, or other equipment).

This NTL also provides guidance for each type of ancillary activity, the type and level of BOEM review, and follow-up, post-survey report requirements.

Seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. Low-energy, high-resolution seismic surveys collect data on surficial geology used to identify potential shallow geologic or manmade hazards (e.g., faults or pipelines) for engineering and site planning for bottom-founded structures. The high-resolution surveys are also used to identify environmental and archaeological resources such as low-relief live-bottom areas, pinnacles, chemosynthetic community habitat, and shipwrecks. High-energy, deep-penetration, common-depth-point (CDP) seismic surveys obtain data about geologic formations thousands of feet below the seafloor. The two-dimensional (2D) and three-dimensional (3D) CDP data are used to map structure features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to map the extent of potential habitat for chemosynthetic communities. In some situations, a set of 3D surveys can be run over a time interval to produce a four-dimensional (4D), or "time-lapse," survey that could be used to characterize production reservoirs.

This Agency completed the programmatic environmental assessment (EA) *Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf* (CSA, 2004a). Upon receiving a complete G&G permit application, BOEM conducts a categorical exclusion review (CER), an EA, or an EIS in accordance with the G&G Programmatic EA's conclusions, NEPA guidelines, and other applicable BOEM policies. When required under an approved coastal management program, proposed G&G permit activities must receive State concurrence prior to BOEM permit approval.

Exploration and Development Plans

To ensure conformance with the OCSLA, other laws, applicable regulations, and lease provisions, and to enable BOEM to carry out its functions and responsibilities, formal plans (30 CFR 250.211 and 250.241) with supporting information must be submitted for review and approval by BOEM before an operator may begin exploration, development, or production activities on any lease. Supporting environmental information, archaeological reports, biological reports (monitoring and/or live-bottom survey), and other environmental data determined necessary must be submitted with an OCS plan. This information provides the basis for an analysis of both offshore and onshore impacts that may occur as a result of the activities. The BOEM may require additional specific supporting information to aid in the evaluation of the potential environmental impacts of the proposed activities. The BOEM can require amendment of an OCS plan based on inadequate or inaccurate supporting information. The 30 CFR 250 Subpart B regulations were revised to update the information that must be submitted with OCS plans and were published in the *Federal Register* on August 30, 2005 (70 FR 167).

The OCS plans are reviewed by geologists, geophysicists, engineers, biologists, archaeologists, air quality specialists, oil-spill specialists, NEPA coordinators, and/or environmental scientists. The plans and accompanying information are evaluated to determine whether any seafloor or drilling hazards are present; that air and water quality issues are addressed; that plans for hydrocarbon resource conservation, development, and drainage are adequate; that environmental issues and potential impacts are properly evaluated and mitigated; and that a proposed action is in compliance with NEPA, CZMA, BOEM operating regulations, and other requirements. Federal agencies, including FWS, NMFS, USEPA, the U.S. Navy, the U.S. Air Force, and USCG, may be consulted if the proposal has the potential to impact areas under their jurisdiction. Each Gulf Coast State has a designated CZM agency that takes part in the review process. The OCS plans are also made available to the general public for comment through the BOEM, Gulf of Mexico OCS Region's Public Information Office.

In response to increasing deepwater activities in the Gulf of Mexico, this Agency developed a comprehensive strategy to address NEPA compliance and environmental issues in the deepwater areas. A key component of that strategy was the completion of a Programmatic EA to evaluate the potential effects of the deepwater technologies and operations (USDOI, MMS, 2000a). As a supplement to the Programmatic EA, this Agency prepared a series of technical papers that provide a summary description of the different types of structures that may be employed in the development and production of hydrocarbon resources in the deepwater areas of the GOM (Regg et al., 2000). The Programmatic EA and technical papers were used in the preparation of this EIS.

On the basis of the BOEM reviews of the OCS plan, the findings of the proposal-specific CER, EA, or EIS, and other applicable BOEM studies and NEPA documents, the OCS plan is approved or disapproved by BOEM, or modified and resubmitted. Although very few OCS plans are ultimately disapproved, many must be amended prior to approval to fully comply with BOEM operating regulations and requirements, or other Federal laws, to address reviewing agencies' concerns, or to avoid potential hazards or impacts to environmental resources.

Exploration Plans

An EP must be submitted to BOEM for review and approval before any exploration activities, except for preliminary activities (such as hazard surveys or geophysical surveys), can begin on a lease. The EP describes exploration activities, drilling rig or vessel, proposed drilling and well-testing operations, environmental monitoring plans, and other relevant information, and includes a proposed schedule of the exploration activities. Guidelines and environmental information requirements for lessees and operators submitting an EP are addressed in 30 CFR 250.211 and are further explained in NTL's 2008-G04, "Shallow Hazards Program," and 2009-G27, "Submitting Exploration Plans and Development Operations Coordination Documents." The NTL 2008-G04 provides guidance on information requirements and establishes the contents for OCS plans required by 30 CFR 250 Subpart B. The NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," effective June 18, 2010, rescinded the limitations set forth in NTL 2008-G04 regarding a blowout and worst-case discharge scenarios and provided national guidance regarding the content of information in blowout and worst-case discharge scenario descriptions. The NTL 2009-G27 clarifies guidance for submitting OCS plans and DOCD's to BOEM's, Gulf of Mexico OCS Region.

After receiving an EP, BOEM determines if the plan is complete and adequate before technical and environmental reviews. The BOEM evaluates the proposed exploration activities for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, State CZMA requirements, and other uses (e.g., military operations) of the OCS. The EP is reviewed for compliance with all applicable laws and regulations.

A CER or EA is prepared as documentation of the environmental review of the EP. The CER or EA is based on available information, which may include the geophysical report (for determining the potential for the presence of deepwater benthic communities); archaeological report; air emissions data; live-bottom survey and report; biological monitoring plan; and recommendations by the affected State(s), DOD, FWS, NMFS, and/or internal BOEM offices. As part of the review process, each EP must contain a certification of consistency and the necessary data and information for the State to determine that the proposed activities comply with the enforceable policies of the States' approved CMP and that such activities will be conducted in a manner that is consistent with the CMP (16 U.S.C. 1456 (c)(3)(A) and 15 CFR 930.76).

If the EP is approved, and prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD) (see *Wells* under *Permits and Applications* below).

Deepwater Operations Plans

In 1992, this Agency formed an internal Deepwater Task Force to address technical issues and regulatory concerns relating to deepwater (>1,000 ft; 305 m) operations and projects utilizing subsea technology. Based on the Deepwater Task Force's recommendation, an NTL (2000-N06) was at first developed that was incorporated into 30 CFR 250 Subpart B. The revisions to Subpart B were finalized August 30, 2005, and required operators to submit a Deepwater Operations Plan (DWOP) for all operations in deep water (400 m [1,312 ft] or greater) and all projects using subsea technology. DeepStar, an industry-wide cooperative workgroup focused on deepwater regulatory issues and critical technology development issues, worked closely with this Agency's Deepwater Task Force to develop the initial guidelines for the DWOP. The DWOP requirement was established to address regulatory issues and concerns that were not addressed in the Agency's then-existing regulatory framework, and it is intended to initiate an early dialogue between BSEE and industry before major capital expenditures on deepwater and subsea projects are committed. Deepwater technology has been evolving faster than BSEE's ability to revise OCS regulations; the DWOP was established through the NTL process, which provides for a more timely and flexible approach to provide guidance on regulatory requirements and keep pace with the expanding deepwater operations and subsea technology.

The DWOP is intended to address the different functional requirements of production equipment in deep water, particularly the technological requirements associated with subsea production systems, and the complexity of deepwater production facilities. The DWOP provides BSEE with information specific to deepwater equipment issues to demonstrate that a deepwater project is being developed in an acceptable manner as mandated in the OCSLA, as amended, and the BSEE operating regulations at 30 CFR 250. The BSEE reviews deepwater development activities from a total system perspective, emphasizing operational safety, environmental protection, and conservation of natural resources. The DWOP process is a phased approach that parallels the operator's state of knowledge about how a field will be developed. A DWOP outlines the design, fabrication, and installation of the proposed development/production system and its components. A DWOP will include structural aspects of the facility (fixed, floating, subsea); station-keeping (includes mooring system); wellbore, completion, and riser systems; safety systems; product removal or offtake systems; and hazards and operability of the production system. The DWOP provides BSEE with the information to determine that the operator has designed and built sufficient safeguards into the production system to prevent the occurrence of significant safety or environmental incidents. The DWOP, in conjunction with other permit applications, provides BSEE the opportunity to assure that the production system is suitable for the conditions in which it will operate.

This Agency recently completed a review of several industry-developed, recommended practices that address the mooring and risers for floating production facilities. The recommended practices address such things as riser design, mooring system design (station-keeping), and hazard analysis. Hazard analyses allow BSEE to be assured that the operator has anticipated emergencies and is prepared to address them, either through their design or through the operation of the equipment in question. This

Agency released these clarifications of its requirements in recent NTL's: NTL 2009-G03, "Synthetic Mooring Systems"; NTL 2009-G11, "Accidental Disconnect of Marine Drilling Risers"; and NTL 2009-G13, "Guidelines for Tie-downs on OCS Production Platforms for Upcoming Hurricane Seasons."

Conservation Reviews

One of BOEM's primary responsibilities is to ensure development of economically producible reservoirs according to sound resource conservation, engineering, and economic practices as cited in 30 CFR 550.202(c), 550.203, 250.204, 250.205, 550.210, 550.296, 550.297, 550.298, 250.299, and 250.1101. Operators should submit the necessary information as part of their EP, initial and supplemental DOCD, and Conservation Information Document. Conservation reviews are performed to ensure that economic reserves are fully developed and produced, and that there is no harm to the ultimate recovery.

Development Operations and Coordination Documents

Before any development operations can begin on a lease in a proposed lease sale area, a DOCD must be submitted to BOEM for review and decision. A DOCD describes the proposed development activities, drilling activities, platforms or other facilities, proposed production operations, environmental monitoring plans, and other relevant information, and it includes a proposed schedule of development and production activities. Requirements for lessees and operators submitting a DOCD are addressed in 30 CFR 550.241-550.242, and information guidelines for DOCD's are provided in NTL's 2008-G04, 2009-G27, and 2010-N06.

After receiving a DOCD, the Bureau of Ocean Energy Management performs technical and environmental reviews. The BOEM evaluates the proposed activity for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, State Coastal Management Plans (CMP) requirements, and other uses (e.g., military operations) of the OCS. The DOCD is reviewed for compliance with all applicable laws and regulations.

A CER, EA, and/or EIS are prepared as documentation of the environmental review of a DOCD. The CER, EA, and/or EIS are based on available information, which may include the geophysical report (for determining the potential for the presence of deepwater benthic communities); archaeological report; air emissions data; live-bottom survey and report; biological monitoring plan; and recommendations by the affected State(s), DOD, FWS, NMFS, and/or internal BOEM offices.

As part of the review process, the DOCD and related environmental analysis may be sent to the affected State(s) for a consistency review under the States' federally approved coastal management program. The OCSLA (43 U.S.C. 1345(a) through (d) and 43 U.S.C. 1351(a)(3)) and CZMA (16 U.S.C. 1456 (c)(3)(A) and 15 CFR 930.76) provide for this coordination and consultation with the affected State and local governments concerning a DOCD.

New or Unusual Technologies

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. New or unusual technologies (NUT's) may be identified by the operator in its EP, DWOP, and DOCD or through BOEM's plan review processes. Some of the technologies proposed for use by the operators are actually extended applications of existing technologies and interface with the environment in essentially the same way as well-known or conventional technologies. These technologies are reviewed by BOEM for alternative compliance or departures that may trigger additional environmental review. Some examples of new technologies that do not affect the environment differently and that are being deployed in the OCS Program are synthetic mooring lines, subsurface safety devices, and multiplex subsea controls.

Some new technologies differ from established technologies in how they function or interface with the environment. These include equipment or procedures that have not been installed or used in Gulf of Mexico OCS waters. Having no operational history, they have not been assessed by BOEM through technical and environmental reviews. New technologies may be outside the framework established by BOEM regulations and, thus, their performance (safety, environmental protection, efficiency, etc.) has not been addressed by BOEM. The degree to which these new technologies interface with the environment and the potential impacts that may result are considered in determining the level of NEPA review that would be initiated.

The BOEM has developed a NUT's matrix to help facilitate decisions on the appropriate level of engineering and environmental review needed for a proposed technology. Technologies will be added to the NUT's matrix as they emerge, and technologies will be removed from the matrix as sufficient experience is gained in their implementation. From an environmental perspective, the matrix characterizes new technologies into three categories: technologies that may affect the environment; technologies that do not interact with the environment any differently than "conventional" technologies; and technologies about which BOEM does not have sufficient information to determine their potential impacts to the environment. In this latter case, BOEM will seek to gain the necessary information from operators or manufacturers regarding the technologies to make an appropriate determination on potential effects on the environment.

Alternative Compliance and Departures: The BSEE's project-specific engineering safety review ensures that equipment proposed for use is designed to withstand the operational and environmental conditions in which it would operate. When an OCS operator proposes the use of new or unusual technology or procedures not specifically addressed in established BSEE regulations, the operations are evaluated for alternative compliance or departure determination. Any new technologies or equipment that represent an alternative compliance or departure from existing BSEE regulations must be fully described and justified before they would be approved for use. For BSEE to grant alternative compliance or departure approval, the operator must demonstrate an equivalent or improved degree of protection as specified in 30 CFR 250.141. Comparative analysis with other approved systems, equipment, and procedures is one tool that BSEE uses to assess the adequacy of protection provided by alternative technology or operations. Actual operational experience is necessary with alternative compliance measures before BSEE would consider them as proven technology.

Emergency Plans

Criteria, models, and procedures for shutdown operations and the orderly evacuation of platforms and rigs for an impending hurricane have been in place in the Gulf of Mexico OCS for more than 30 years. (Such emergency plans are different from the oil-spill response plans described later in this chapter.) Operating experience from extensive drilling activities and more than 4,000 platforms during the 30-plus years of the Gulf of Mexico OCS Program have demonstrated the effectiveness and safety of securing wells and evacuating a facility in advance of severe weather conditions. Preinstallation efforts, historical experience with similar systems, testing, and the actual operating experience (under normal conditions and in response to emergency situations) are used to formulate the exact time needed to secure the wells and production facility and to evacuate it as necessary. Operators develop site-specific curtailment, securing, and evacuation plans that vary in complexity and formality by operator and type of activity. In general terms, all plans are intended to make sure the facility (or well) is secured in advance of an impending storm or developing emergency. The operating procedures developed during the engineering, design, and manufacturing phases of the project, coupled with the results (recommended actions) from hazard analyses performed, are used to develop the emergency action and curtailment plans. Evacuation and production curtailment must consider a combination of factors, including the well status (drilling, producing, etc.) and the type and mechanics of wellbore operations. These factors are analyzed onsite through a decisionmaking process that involves onsite facility managers. The emphasis is on making real-time, situation-specific decisions and forecasting based on available information. Details of the shut-in criteria and various alerts are addressed on a case-by-case basis, as explained below.

Plans for shutting in production from the subsea wells are addressed as part of the emergency curtailment plan. The plan specifies the various alerts and shutdown criteria linked to both weather and facility performance data, with the intent to have operations suspended and the wells secured in the event of a hurricane or emergency situation. Ensuring adequate time to safely and efficiently suspend operations and secure the well is a key component of the planning effort. Clearly defined responsibilities for the facility personnel are part of the successful implementation of the emergency response effort.

For a severe weather event such as a hurricane, emergency curtailment plans would address the criteria and structured procedures for suspending operations and ultimately securing the wellbore(s) prior to weather conditions that could exceed the design operating limitations of the drilling or production unit.

For drilling operations, the plan might also address procedures for disconnecting and moving the drilling unit off location after the well has been secured, should the environmental conditions exceed the floating drilling unit's capability to maintain station. Curtailment of operations consists of various stages of "alerts" indicating the deterioration of meteorological, oceanographic, or wellbore conditions. Higher alert levels require increased monitoring, the curtailment of lengthy wellbore operations, and, if conditions warrant, the eventual securing of the well. If conditions improve, operations could resume based on the limitations established in the contingency plan for the known environmental conditions. The same emergency curtailment plans would be implemented in an anticipated or impending emergency situation, such as the threat of a terrorist attack.

Neither BSEE nor USCG mandates that an operator must evacuate a production facility for a hurricane; it is a decision that rests solely with the operator. The USCG does require the submittal of an emergency evacuation plan that addresses the operator's intentions for evacuation of nonessential personnel, egress routes on the production facility, lifesaving and personnel safety devices, firefighting equipment, etc. As activities move farther from shore, it may become safer to not evacuate the facility because helicopter operations become inherently more risky with greater flight times. Severe weather conditions also increase the risks associated with helicopter operations. The precedent for leaving a facility manned during severe weather is established in the North Sea and other operating basins.

Redundant, fail-safe, automatic shut-in systems located inside the wellbore and at the sea surface, and in some instances at the seafloor, are designed to prevent or minimize pollution. These systems are designed and tested to ensure proper operation should a production facility or well be catastrophically damaged. Testing occurs at regular intervals with predetermined performance limits designed to ensure functioning of the systems in case of an emergency. After the DWH event, the testing requirements for well control systems came under immediate scrutiny in the DOI Secretary's "Safety Measures Report," which was delivered to him on May 27, 2010. The Safety Measures Report included a recommendation of a program for immediate recertification of BOP's. As stated above, the new regulatory section at 30 CFR 250.451(i) requires that, if a blind-shear ram or casing shear ram is activated in a well control situation where the pipe is sheared, the BOP stack must be retrieved, fully inspected, and tested (*Federal Register*, 2010b). This and other new regulations that improve safety in the event of an emergency are described above in **Chapter 1.3.1**.

Permits and Applications

After EP or DOCD approval, the operator submits applications for specific activities to BOEM for approval. These applications include those for drilling wells; well-test flaring; temporary well abandonment; installing a well protection structure, production platforms, satellite structures, subsea wellheads and manifolds, and pipelines; installation of production facilities; commencing production operations; platform removal and lease abandonment; and pipeline decommissioning.

Wells

The BSEE requirements for the drilling of wells can be found at 30 CFR 250 Subpart D. Lessees are required to take precautions to keep all wells under control at all times. The lessee must use the best available and safest technology to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow.

Prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD). The APD requires detailed information—including project layout at a scale of 24,000:1, design criteria for well control and casing, specifications for blowout preventers, a mud program, cementing program, directional drilling plans, etc.—to allow for BOEM's evaluation of operational safety and pollution-prevention measures. The APD is reviewed for conformance with the engineering requirements and other technical considerations.

The BSEE is responsible for conducting technical and safety reviews of all drilling, workover, and production operations on the OCS. These detailed analyses determine if the lessee's proposed operation is in compliance with all regulations and all current health, safety, environmental, and classical engineering standards.

The BSEE regulations at 30 CFR 250.1710-1717 address the requirements for permanent abandonment of a well on the OCS. A permanent abandonment includes the isolation of zones in the open wellbore, plugging of perforated intervals, plugging the annular space between casings (if they are open), setting a surface plug, and cutting and retrieving the casing at least 15 ft (5 m) below the mudline. All plugs must be tested in accordance with the regulations. There are no routine surveys of permanently abandoned well locations. If a well were found to be leaking, BOEM would require the operator of record to perform an intervention to repair the abandonment. If a well is temporarily abandoned at the seafloor, an operator must provide BSEE with an annual report summarizing plans to permanently abandon the well or to bring the well into production.

Platforms and Structures

The BSEE does a technical review of all proposed structure designs and installation procedures. All proposed facilities are reviewed for structural integrity. These detailed engineering reviews entail an evaluation of all operator proposals for fabrication, installation, modification, and repair of all mobile and fixed structures. The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations. Applications for platform and structure approval are filed in accordance with 30 CFR 250.901. Design requirements are presented in detail at 30 CFR 250.904 through 250.909. The lessee evaluates characteristic environmental conditions associated with operational functions to be performed. Factors such as waves, wind, currents, tides, temperature, and the potential for marine growth on the structure are considered. In addition, pursuant to 30 CFR 250.902 and 250.903, a program has been established by BSEE to assure that new structures meeting the conditions listed under 30 CFR 250.900(c) are designed, fabricated, and installed using standardized procedures to prevent structural failures. This program facilitates review of such structures and uses third-party expertise and technical input in the verification process through the use of a Certified Verification Agent. After installation, platforms and structures are required to be periodically inspected and maintained under 30 CFR 250.912.

Pipelines

Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies, including DOI, Department of Transportation (DOT), U.S. Army Corps of Engineers (COE), the Federal Energy Regulatory Commission, and the USCG. Aside from pipeline regulations, these agencies have the responsibility of overseeing and regulating the following areas: the placement of structures on the OCS and pipelines in areas that affect navigation; the certification of proposed projects involving the transportation or sale of interstate natural gas, including OCS gas; and the right of eminent domain exercised by pipeline companies onshore. In addition, DOT is responsible for promulgating and enforcing safety regulations for the transportation in interstate commerce of natural gas, liquefied natural gas (LNG), and hazardous liquids by pipeline. This includes, for the most part, offshore pipelines on State lands beneath navigable waters and on the OCS that are operated by transmission companies. The regulations are contained in 49 CFR 191 through 193 and 195. In a Memorandum of Understanding (MOU) between DOT and DOI dated December 10, 1996, each party's respective regulatory responsibilities are outlined. The DOT is responsible for establishing and enforcing design, construction, operation, and maintenance regulations, and for investigating accidents for all OCS transportation pipelines beginning downstream of the point at which operating responsibility transfers from a producing operator to a transporting operator. The DOI's responsibility extends upstream from the transfer point described above.

The BSEE is responsible for regulatory oversight of the design, installation, and maintenance of OCS producer-operated oil and gas pipelines. The BSEE's operating regulations for pipelines, found at 30 CFR 250 Subpart J, are intended to provide safe and pollution-free transportation of fluids in a manner that does not unduly interfere with other users of the OCS. Pipeline applications are usually submitted and reviewed separately from DOCD's. Pipeline applications may be for on-lease pipelines or rights-of-way for pipelines that cross other lessees' leases or unleased areas of the OCS. Pipeline permit applications to BSEE include the pipeline location drawing, profile drawing, safety schematic drawing, pipe design data, a shallow hazard survey report, and an archaeological report, if applicable.

The BSEE evaluates the design, fabrication, installation, and maintenance of all OCS pipelines. Proposed pipeline routes are evaluated for potential seafloor or subsea geologic hazards and other natural or manmade seafloor or subsurface features or conditions (including other pipelines) that could have an adverse impact on the pipeline or that could be adversely impacted by the proposed operations. Routes are also evaluated for potential impacts on archaeological resources and biological communities. A NEPA review is conducted in accordance with applicable policies and guidelines. The BOEM prepares an EA on all pipeline rights-of-way that go ashore. For Federal consistency, applicants must comply with the regulations as clarified in NTL 2007-G20, "Coastal Zone Management Program Requirements for OCS Right-of-way Pipeline Applications." All Gulf States require consistency review of right-of-way pipeline applications as described in the clarifying NTL.

The design of the proposed pipeline is evaluated for an appropriate cathodic protection system to protect the pipeline from leaks resulting from the effects of external corrosion of the pipe; an external pipeline coating system to prolong the service life of the pipeline; measures to protect the inside of the pipeline from the detrimental effects, if any, of the fluids being transported; the submersibility of the line (i.e., that the pipeline will remain in place on the seafloor and not have the potential to float, even if empty or filled with gas rather than liquids); proposed operating pressure of the line; and protection of other pipelines crossing the proposed route. Such an evaluation includes the following: (1) reviewing the calculations used by the applicant in order to determine whether the applicant properly considered such elements as the grade of pipe to be used, the wall thickness of the pipe, derating factors (the practice of operating a component well inside its normal operating limits to reduce the rate at which the component deteriorates), related to the submerged and riser portions of the pipeline, the pressure rating of any valves or flanges to be installed in the pipeline, the pressure rating of any other pipeline(s) into which the proposed line might be tied, and the required pressure to which the line must be tested before it is placed in service; (2) protective safety devices such as pressure sensors and remotely operated valves, the physical arrangement of those devices proposed to be installed by the applicant for the purposes of protecting the pipeline from possible overpressure conditions and for detecting and initiating a response to abnormally low-pressure conditions; and (3) the applicant's planned compliance with regulations requiring that pipelines installed in water depths less than 200 ft (61 m) be buried to a depth of at least 3 ft (1 m) (30 CFR 250.1003). In addition, pipelines crossing fairways require a COE permit and must be buried to a depth of at least 10 ft (3 m) and to 16 ft (5 m) if crossing an anchorage area.

Operators are required to periodically inspect pipeline routes. Monthly overflights are conducted to inspect pipeline routes for leakage.

Applications for pipeline decommissioning must also be submitted for BOEM review and approval. Decommissioning applications are evaluated to ensure they will render the pipeline inert and/or to minimize the potential for the pipeline becoming a source of pollution by flushing and plugging the ends and to minimize the likelihood that the decommissioned line will become an obstruction to other users of the OCS by filling it with water and burying the ends.

Inspection and Enforcement

The OCSLA authorizes and requires BSEE to provide for both an annual scheduled inspection and a periodic unscheduled (unannounced) inspection of all oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation.

The primary objective of an initial inspection is to assure proper installation of mobile drilling units and fixed structures, and proper functionality of their safety and pollution prevention equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain a BSEE presence, and to focus on operators with a poor performance record. These inspections are also conducted after a critical safety feature has previously been found defective. Poor performance generally means that more frequent, unannounced inspections may be conducted on a violator's operation.

The annual inspection examines all safety equipment designed to prevent blowouts, fires, spills, or other major accidents. These annual inspections involve the inspection for installation and performance of all facilities' safety-system components.

The inspectors follow the guidelines as established by the regulations, API RP 14C, and the specific BSEE-approved plan. The BSEE inspectors perform these inspections using a national checklist called the Potential Incident of Noncompliance (PINC) list. This list is a compilation of yes/no questions derived from all regulated safety and environmental requirements.

The BSEE administers an active civil penalties program (30 CFR 250 Subpart N). A civil penalty in the form of substantial monetary fines may be issued against any operator that commits a violation that may constitute a threat of serious, irreparable, or immediate harm or damage to life, property, or the environment. The BSEE may make recommendations for criminal penalties if a willful violation occurs. In addition, the regulation at 30 CFR 250.173(a) authorizes suspension of any operation in the Gulf of Mexico Region if the lessee has failed to comply with a provision of any applicable law, regulation, or order or provision of a lease or permit. Furthermore, the Secretary may invoke his authority under 30 CFR 550.185(c) to cancel a nonproductive lease with no compensation. Exploration and development activities may be canceled under 30 CFR 550.182 and 550.183.

Pollution Prevention, Oil-Spill Response Plans, and Financial Responsibility

Pollution Prevention

Pollution prevention is addressed through proper design and requirements for safety devices. The BSEE regulations at 30 CFR 250.400 require that the operator take all necessary precautions to keep its wells under control at all times. The lessee is required to use the best available and safest drilling technology in order to enhance the evaluation of conditions of abnormal pressure and to minimize the potential for the well to flow or kick. Redundancy is required for critical safety devices that will shut off flow from the well if loss of control is encountered. A complete description of rule changes implemented as a result of the DWH event is detailed in **Chapter 1.3.1**.

In addition, BSEE regulations at 30 CFR 250 Subparts E, F, and H require that the lessee assure the safety and protection of the human, marine, and coastal environments during completion, workover, and production operations. All production facilities, including separators, treaters, compressors, headers, and flowlines are required to be designed, installed, tested, maintained, and used in a manner that provides for efficiency, safety of operations, and protection of the environment. Wells, particularly subsea wells, include a number of sensors that help in detecting pressures and the potential for leaks in the production system. Safety devices are monitored and tested frequently to ensure their operation, should an incident occur. To ensure that safety devices are operating properly, BSEE incorporates the API RP 14C into the operating regulations. The API RP 14C incorporates the knowledge and experience of the oil and gas industry regarding the analysis, design, installation, and testing of the safety devices used to prevent pollution. The API RP 14C presents proven practices for providing these safety devices for offshore production platforms. Proper application of these practices, along with good design, maintenance, and operation of the entire production facility, should provide an operationally safe and pollution-free production platform.

Also, BSEE regulations at 30 CFR 250 Subpart J require that pipelines and associated valves, flanges, and fittings be designed, installed, operated, and maintained to provide safe and pollution-free transportation of fluids in a manner that does not unduly interfere with other uses on the OCS.

The BSEE regulation at 30 CFR 250.300(a) requires that lessees not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean during offshore oil and gas operations. The lessee is required to take measures to prevent the unauthorized discharge of pollutants into the offshore waters. Control and removal of pollution is the responsibility and at the expense of the lessee. Immediate corrective action in response to an unauthorized release is required. All hydrocarbon-handling equipment for testing and production, such as separator and treatment tanks, is required to be designed, installed, and operated to prevent pollution. Maintenance and repairs that are necessary to prevent pollution are required to be taken immediately. Drilling and production facilities are required to be inspected daily or at intervals approved or prescribed by the BSEE District Field Operations Supervisor to determine if pollution is occurring.

Operators are required to install curbs, gutters, drip pans, and drains on platform and rig deck areas in a manner necessary to collect all greases, contaminants, and debris not authorized for discharge. The rules also explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items must be marked in a durable manner with the owner’s name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use. Operational discharges such as produced water and drilling muds and cuttings are regulated by USEPA through the National Pollutant

Discharge Elimination System (NPDES) permit program for new and existing discharges and sources (40 CFR 435 Subpart A). The BSEE may restrict the rate of drilling fluid discharge or prescribe alternative discharge methods. No petroleum-based substances, including diesel fuel, may be added to the drilling mud system without prior approval of the BSEE District Field Operations Supervisor.

Blowout Preventers

A blowout preventer (BOP) is a complex of choke lines and hydraulic rams mounted atop the well head that can seal off the casing of a well by remote control at the surface. There are different types of BOP's. A pipe ram closes on the drill pipe by pinching it, but it cannot seal on open hole. A blind ram is a straight-edged rams used to close an open hole. The BOP's were invented in the early 1920's and have been instrumental in ending dangerous, costly, and environmentally damaging oil gushers. The BOP's have been required for OCS oil and gas operations from the time offshore drilling began in the late 1940's. There are two types: ram and annular (also called spherical). Rams were deployed in the 1920's and annular preventers in the 1950's. Rams are designed to seal an open hole by closing the wellbore with a sharp horizontal motion that may cut through casing or tool strings, as a last resort. An annular BOP closes around the drill string in a smooth simultaneous upward and inward motion. Both types are usually used together to create redundancy in a BOP stack. Because BOP's are important for the safety of the drilling crew, as well as the rig and the wellbore itself, BOP's are regularly inspected, tested, and refurbished. The BOP's are actuated as a last resort upon imminent threat to the integrity of the well or the surface rig (**Chapter 3.2.2**). New regulations for BOP's were published on October 14, 2010, as described in **Chapter 1.3.1** (*Federal Register*, 2010b).

Oil-Spill-Response Plans

The BSEE's responsibilities under the Oil Pollution Act of 1990 (OPA) include spill prevention, review, and approval of oil-spill-response plans (OSRP's); inspection of oil-spill containment and cleanup equipment; and ensuring oil-spill financial responsibility for facilities in offshore waters located seaward of the coastline or in any portion of a bay that is connected to the sea either directly or through one or more other bays. The BSEE regulations (30 CFR 254) require that all owners and operators of oil-handling, storage, or transportation facilities located seaward of the coastline submit an OSRP for approval. The term "coastline" means the line of ordinary low water along that portion of the coast that is in direct contact with the open sea and the line marking the seaward limit of inland waters. The term "facility" means any structure, group of structures, equipment, or device (other than a vessel), which is used for one or more of the following purposes: exploring for; drilling for; producing; storing; handling; transferring; processing; or transporting oil. A mobile offshore drilling unit (MODU) is classified as a facility when engaged in drilling or downhole operations.

The regulation at 30 CFR 254.2 requires that an OSRP must be submitted and approved before an operator can use a facility. The BSEE can grant an exception to this requirement during the BSEE review of an operator's submitted OSRP. In order to be granted this exception during this time period, an owner/operator must certify in writing to BSEE that it is capable of responding to a "worst-case" spill or the substantial threat of such a spill. To continue operations, the facility must be operated in compliance with the approved OSRP or the BSEE-accepted "worst-case" spill certification. Owners or operators of offshore pipelines are required to submit an OSRP for any pipeline that carries oil, condensate, or gas with condensate; pipelines carrying essentially dry gas do not require an OSRP. Current OSRP's are required for abandoned facilities until they are physically removed or dismantled.

The OSRP describes how an operator intends to respond to an oil spill. The OSRP may be site-specific or regional (30 CFR 254.3). The term "regional" means a spill response plan that covers multiple facilities or leases of an owner or operator, including affiliates, which are located in the same BSEE Gulf of Mexico region. The subregional plan concept is similar to the regional concept, which allows leases or facilities to be grouped together for the purposes of (1) calculating response times, (2) determining quantities of response equipment, (3) conducting oil-spill trajectory analyses, (4) determining worst-case discharge scenarios, and (5) identifying areas of special economic and environmental importance that may be impacted and the strategies for their protection. The number and location of the leases and facilities allowed to be covered by a subregional OSRP will be decided by BSEE on a case-by-case basis considering the proximity of the leases or facilities proposed to be covered. NTL 2006-G21 includes guidance on the preparation and submittal of subregional OSRP's.

The Emergency Response Action Plan within the OSRP serves as the core of the BSEE-required OSRP. In accordance with 30 CFR 254, the Emergency Response Action Plan requires identification of (1) the qualified individual and the spill-response management team, (2) the spill-response operating team, (3) the oil-spill cleanup organizations under contract for response, and (4) the Federal, State, and local regulatory agencies that an owner/operator must notify or that they must consult with to obtain site-specific environmental information when an oil spill occurs. The OSRP is also required to include an inventory of appropriate equipment and materials, their availability, and the time needed for deployment, as well as information pertaining to dispersant use, in-situ burning, a worst-case discharge scenario, contractual agreements, training and drills, identification of potentially impacted environmental resources and areas of special economic concern and environmental importance, and strategies for the protection of these resources and areas. The response plan must provide for response to an oil spill from the facility and the operator must immediately carry out the provisions of the plan whenever an oil spill from the facility occurs. The OSRP must be in compliance with the National Contingency Plan and the Area Contingency Plan(s) (ACP). The operator is also required to carry out the training, equipment testing, and periodic drills described in the OSRP. All BSEE-approved OSRP's must be reviewed at least every 2 years. In addition, revisions must be submitted to BSEE within 15 days whenever

(1) a change occurs that appreciably reduces an owner/operator's response capabilities;

(2) a substantial change occurs in the worst-case discharge scenario or in the type of oil being handled, stored, or transported at the facility;

(3) there is a change in the name(s) or capabilities of the oil-spill removal organizations cited in the OSRP; or

(4) there is a change in the applicable ACP's.

As a result of the DWH event, although BSEE is not requiring the submission of revised OSRP's at this time, the Agency will provide guidance regarding additional information that operators should submit regarding spill response and surface containment in light of the "worst case" discharge calculations that are now required by the regulations and as clarified in NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," which became effective on June 18, 2010. This NTL provides clarification of the regulations requiring a lessee or operator to submit supplemental information for new or previously submitted EP's, development and production plans (DPP's), or DOCD's. The required supplemental information includes the following: (1) a description of the blowout scenario as required by 30 CFR 550.213(g) and 550.243(h); (2) a description of their assumptions and calculations used in determining the volume of the worst-case discharge required by 30 CFR 550.219(a)(2)(iv) (for EP's) or 30 CFR 550.250(a)(2)(iv) (for DPP's and DOCD's); and (3) a description of the measures proposed that would enhance the ability to prevent a blowout, to reduce the likelihood of a blowout, and to conduct effective and early intervention in the event of a blowout, including the arrangements for drilling relief wells and any other measures proposed. The early intervention methods could actually include the surface and subsea containment resources that BOEMRE announced in NTL 2010-N10, which states that BOEMRE will begin reviewing to ensure that the measures are adequate to promptly respond to a blowout or other loss of well control.

Additionally, to address new improved containment systems, NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," became effective on November 8, 2010. This NTL applies only to operators conducting operations using subsea or surface BOP's on floating facilities. It clarifies the regulations that lessees and operators must submit a certification statement signed by an authorized company official with each application for a well permit, indicating that they will conduct all of their authorized activities in compliance with all applicable regulations, including the Increased Safety Measures Regulations at 75 FR 63346. The NTL also informs lessees that BSEE will be evaluating whether or not each operator has submitted adequate information demonstrating that it has access to and can deploy surface and subsea containment resources that would be adequate to promptly respond to a blowout or other loss of well control. Although the NTL does not provide that operators submit revised OSRP's that include this containment information at this time, operators were notified of BSEE's intention to evaluate the adequacy of each operator to comply in the operator's current OSRP; therefore, there is an incentive for voluntary compliance.

Financial Responsibility

The responsible party for covered offshore facilities (COF's) must demonstrate oil spill financial responsibility (OSFR), as required by 30 CFR 253. These regulations implement the OSFR requirements of Title I of OPA, as amended. Penalties for noncompliance with these requirements are covered at 30 CFR 250.51 and in NTL 2008-N05, "Guidelines for Oil Spill Financial Responsibility for Covered Facilities." A COF, as defined in 30 CFR 253.3, is any structure and all of its components (including wells completed at the structure and the associated pipelines), equipment, pipeline, or device (other than a vessel or other than a pipeline or deepwater port licensed under the Deepwater Port Act of 1974) used for exploring, drilling, or producing oil, or for transporting oil from such facilities. The BSEE ensures that each responsible party has sufficient funds for removal costs and damages resulting from the accidental release of liquid hydrocarbons into the environment for which the responsible party is liable.

Air Emissions

The OCSLA (43 U.S.C. 1334(a)(8)) requires the Secretary of the Interior to promulgate and administer regulations that comply with the National Ambient Air Quality Standards (NAAQS), pursuant to the Clean Air Act (CAA) (42 U.S.C. 7401 et seq.), to the extent that authorized activities significantly affect the air quality of any State. Under provisions of the CAA Amendments (CAAA) of 1990, the USEPA Administrator has jurisdiction and, in consultation with the Secretary of the Interior and the Commandant of the Coast Guard, established the requirements to control air pollution in OCS areas of the Pacific, Atlantic, Arctic, and eastward of 87.5^{o} W. longitude in the GOM. Air quality in the OCS area westward of 87.5^{o} W. longitude in the Gulf is under BOEM jurisdiction.

For OCS air emission sources located east of 87.5^{o} W. longitude and within 25 mi (40 km) of the States' seaward boundaries, the requirements are the same as would be applicable if the source were located in the corresponding onshore area. The USEPA requirements for these OCS areas are at 40 CFR 55, Appendix A. For air emission sources located east of 87.5^{o} W. longitude and more than 25 mi (40 km) from the States' seaward boundaries, sources are subject to Federal requirements for Prevention of Significant Deterioration (PSD). The USEPA regulations also establish procedures that allow the USEPA Administrator to exempt any OCS source from an emissions control requirement if it is technically infeasible or poses unreasonable threat to health or safety.

This Agency issued NTL 2009-N11 to clarify that its regulatory authority and the BOEM implementing regulations in 30 CFR 250 Subpart C apply only to those air emission sources in the Gulf of Mexico westward of 87.5º W. longitude. The regulated pollutants include carbon monoxide, suspended particulates, sulphur dioxide, nitrogen oxides, total hydrocarbons, and volatile organic compounds. All new or supplemental EP's and DOCD's must include air emissions information sufficient to determine whether an air quality review is required (30 CFR 550.218 and 550.249). The BOEM regulations require a review of air quality emissions to determine if the projected emissions from a facility result in onshore ambient air concentrations above BOEM significance levels and to identify appropriate emissions controls to mitigate potential onshore air quality degradation.

Emissions data for new or modified onshore facilities directly associated with proposed OCS activities are required to be included in development plans submitted to BOEM so that affected States can determine potential air quality impacts on their air quality.

The BOEM uses a two-level hierarchy of evaluation criteria to evaluate potential impacts of offshore emission sources to onshore areas. The evaluation criteria are the exemption level and the significance level. If the proposed activities exceed the criteria at the first (exemption) level, the evaluation moves to the significance level criteria. The initial evaluation compares the worst-case emissions to the BOEM exemption criteria. This corresponds to the USEPA screening step, where the proposed activity emissions are checked against the screening thresholds or "exemption levels." If the proposed activity emissions are below the exemption levels, the proposed action is exempt from further air quality review.

If exemption levels are exceeded, then the second step requires refined modeling using the Offshore and Coastal Dispersion (OCD) Model. The results from the OCD Model, the modeled potential onshore impacts, are compared with BOEM significance levels. If the significance levels are exceeded in an attainment area, an area that meets the NAAQS, the operator would be required to apply best available control technology to the emissions source. If the affected area is classified as nonattainment, further emission reductions or offsets may be required. Projected contributions to onshore pollutant concentrations are also subject to the same limits as USEPA applies to the onshore areas under their PSD program.

Flaring/Venting

Flaring is the controlled burning of natural gas, and venting is releasing gas directly into the atmosphere without burning. Flaring/venting may be necessary to remove potentially damaging completion fluids from the wellbore and to provide sufficient reservoir data for the operator to evaluate reservoir development options during unloading/testing operations and/or in emergency situations. The BSEE regulates flaring/venting to minimize the loss of revenue producing natural gas resources. The BSEE regulations (30 CFR 250) allow, without prior BSEE approval, flaring or venting of natural gas on a limited basis under certain specified conditions. Regulations permit more extensive flaring/venting with prior approval from BSEE. Records must always be prepared by the operator for all flaring/venting, and justification must be provided for flaring/venting not expressly authorized by BSEE regulations.

Hydrogen Sulfide Contingency Plans

The operator of a lease must request a BSEE area classification for the presence of hydrogen sulfide (H_2S) gas. The BSEE classifies areas for proposed operations as (1) H_2S absent, (2) H_2S present, or (3) H_2S unknown.

All OCS operators must provide information about potential contact with sour hydrocarbons (contains H_2S) that could result in atmospheric H_2S concentrations above 20 parts per million in their exploration or development plan. If an area is known to contain H_2S or is in an area where H_2S potential is unknown, operators are required to file an H_2S contingency plan with BSEE. This plan must include the 30 CFR 250 requirements that are intended to ensure workers' safety at the production facility and provide contingencies for simultaneous drilling, well-completion, well-workovers, and production operations. The NTL 2009-G31, "Hydrogen Sulfide (H_2S) Requirements," provides clarification, guidance, and information regarding BSEE's H_2S regulations at 30 CFR 250.

Archaeological Resources Regulation

Bottom-disturbing operations such as well placement, anchoring, and pipelaying activities can lead to damage to any resources that reside on and below the seabed, including archaeological resources such as historic shipwrecks. The archaeological resources regulation at 30 CFR 250.194 and 550.194 grants authority in certain cases to each BOEM and BSEE Regional Director to require that archaeological reports be submitted with the EP, DOCD, or DPP where deemed necessary. The technical requirements of the archaeological resource reports are detailed in NTL 2005-G07, "Archaeological Resource Surveys and Reports." If the evidence from the operator's geophysical survey and/or archaeological report suggests that an archaeological resource may be present, the lessee must either locate the site of any operation so as not to adversely affect the area where the archaeological resource may be, demonstrate that an archaeological resource does not exist, or demonstrate that archaeological resources will not be adversely affected by operations. If the lessee discovers any archaeological resource while conducting approved operations, operations must be immediately stopped and the discovery reported to the BOEM Regional Supervisor, Office of Environment, within 48 hours of its discovery.

High-resolution surveys, where required, provide an effective tool that analysts use to identify and help protect archaeological resources; however, such survey coverage is often not available for all areas of the GOM, particularly in deeper water where oil and gas activities are increasing and where more shipwrecks are being identified. As part of the environmental reviews conducted for postlease activities, available information will be evaluated regarding the potential presence of archaeological resources within a proposed action area to determine if mitigation is warranted.

Coastal Zone Management Consistency Review and Appeals for Plans

The Coastal Zone Management Act (CZMA) places requirements on any applicant for an OCS plan that describes in detail Federal license or permit activities affecting any coastal use or resource, in or outside of a State's coastal zone. The applicant must provide in the OCS plan submitted to BOEM a consistency certification and necessary data and information for the State to determine that the proposed activities comply with the enforceable policies of the State's coastal management program (CMP), approved by NOAA, and that such activities will be fully consistent with those enforceable policies (16 U.S.C. 1456(c)(3)(A) and 15 CFR 930.76).

Except as provided in 15 CFR 930.60(a), State agency consistency review begins when the State receives the OCS plan, consistency certification, and necessary data and information pursuant to 15 CFR 930.76(a) and (b). Only missing information can be used to delay the commencement of State agency review, and a request for information and data that are not required by 15 CFR 930.76 will not extend the date of commencement of review (15 CFR 930.58). The information requirements for CZM purposes are found at 30 CFR 250.226 and 250.260 and are discussed in NTL 2006-G21, "Regional and Subregional Oil Spill Response Plans"; NTL 2007-G20, "Coastal Zone Management Program Requirements for OCS Right-of-Way Pipeline Applications"; NTL 2008-G04, "Information Requirements for Exploration Plans and Development Operations Coordination Documents"; NTL 2009-G27, "Submitting Exploration Plans and Development Operations Coordination Documents"; NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS"; and NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources."

All of the Gulf States have approved CMP's. Requirements for the CZM consistency information for Texas, Louisiana, Mississippi, Alabama, and Florida are given in NTL's 2006-G21, 2007-G20, 2008-G04, 2009-G27, and 2010-N06. In accordance with the requirements of 15 CFR 930.76, the BOEM's Gulf of Mexico OCS Region sends copies of an OCS plan, including the consistency certification and other necessary data and information, to the designated State CMP agency by receipted mail or other approved communication. If no State-agency objection is submitted by the end of the consistency review period, BOEM shall presume consistency concurrence by the State (15 CFR 930.78(b)). The BOEM can require modification of a plan.

If BOEM receives a written consistency objection from the State, BOEM will not approve any activity described in the OCS plan unless (1) the operator amends the OCS plan to accommodate the objection, concurrence is subsequently received or conclusively presumed; (2) upon appeal, the Secretary of Commerce, in accordance with 15 CFR 930 Subpart H, finds that the OCS plan is consistent with the objectives or purposes of the CZMA or is necessary in the interest of national security; or (3) the original objection is declared invalid by the courts.

Best Available and Safest Technologies

To assure that oil and gas exploration, development, and production activities on the OCS are conducted in a safe and pollution-free manner, 43 U.S.C. 1347(b) of the OCSLA, as amended, requires that all OCS technologies and operations use the best available and safest technology (BAST) whenever practical. The Director may require additional BAST measures to protect safety, health, and the environment, if it is economically feasible and the benefits outweigh the costs. Conformance to the standards, codes, and practices referenced in or required under the authority of 30 CFR 250 is considered the application of BAST. These standards, codes, and practices include requirements for state-of-the-art drilling technology, production safety systems, oil and gas well completions, oil-spill response plans, pollution-control equipment, and specifications for platform/structure designs. The BSEE conducts periodic offshore inspections and continuously and systematically reviews OCS technologies to ensure that the best available and safest technologies are applied to OCS operations. The BAST is not required when BSEE determines that the incremental benefits are clearly insufficient to justify increased costs; however, it is the responsibility of an operator of an existing operation to demonstrate why application of a new technology would not be feasible. The BAST requirement is applicable to equipment and procedures that, upon failure, would have a significant effect on safety, health, or the environment, unless benefits clearly do not justify the cost (30 CFR 550.107(c) and (d)).

The BAST concept is addressed in the BSEE, Gulf of Mexico OCS Region by a continuous effort to locate and evaluate the latest technologies and to report on these advances at periodic Regional Operations Technology Assessment Committee (ROTAC) meetings. A part of the BSEE staff has an ongoing function to evaluate various vendors and industry representatives' innovations and improvements in techniques, tools, equipment, procedures, and technologies applicable to oil and gas operations (drilling, producing, completion, and workover operations). This information is provided to BSEE district personnel at ROTAC meetings. The requirement for the use of BAST has been, for the most part, an evolutionary process whereby advances in equipment, technologies, and procedures have been integrated into OCS operations over a period of time. Awareness by both BSEE inspectors and the OCS operators of the most advanced equipment and technologies has resulted in the incorporation of these advances into day-to-day operations. An example of such an equipment change that evolved over a period of time would be the upgrading of diverter systems on drilling rigs from the smaller diameter systems of the past to the large-diameter, high-capacity systems found on drilling rigs operating on the OCS today.

Production Facilities

The BSEE's regulations governing oil and gas production safety systems are found in 30 CFR 250 Subpart H. Production safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. All tubing installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that will shut off the flow from the well in the event of an emergency, unless the well is incapable of flowing. Surface- and subsurface-controlled safety valves and locks must conform to the requirements of 30 CFR 250.801. All surface production facilities, including separator and treatment tanks, compressors, headers, and flowlines must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment. Production facilities also have stringent requirements concerning electrical systems, flowlines, engines, and firefighting systems. The safety-system devices are tested by the lessee at specified intervals and must be in accordance with API RP 14 C Appendix D and other measures.

Personnel Training and Education

An important factor in ensuring that offshore oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage is the proper training of personnel. Under 30 CFR 250.1500 Subpart O, BSEE has outlined well control and production safety training program requirements for lessees operating on the OCS. The goal of the regulation (30 CFR 250.1501) is safe and clean OCS operations. Lessees must ensure that their employees and contract personnel engaged in well control or production safety operations understand and can properly perform their duties. To accomplish this, the lessee must establish and implement a training program so that all of its employees are trained to competently perform their assigned well control and production safety duties. The lessee must also verify that its employees understand and can perform the assigned duties.

The mandatory Drilling Well-Control Training Program was instituted by this Agency in 1979. In 1983, the mandatory Safety Device Training Program was established to ensure that personnel involved in installing, inspecting, testing, and maintaining safety devices are qualified. As a preventive measure, all offshore personnel must be trained to operate oil-spill cleanup equipment, or the lessee must retain a trained contractor(s) to operate the equipment for them. In addition, BSEE offers numerous technical seminars to ensure that personnel are capable of performing their duties and are incorporating the most up-to-date safety procedures and technology in the petroleum industry. In 1994, the Office of Safety Management created this Agency's Offshore Training Institute to develop and implement an inspector training program. The Institute introduced state-of-the-art multimedia training to the inspector work force and has produced a series of interactive computer training modules.

Structure Removal and Site Clearance

During exploration, development, and production operations, temporary and permanent equipment and structures are often required to be embedded into or placed onto the seafloor around activity areas. In compliance with Section 22 of BSEE's Oil and Gas Lease Form (MMS-2005) and OCSLA regulations (30 CFR 250.1710—*Wellheads/Casings* and 30 CFR 250.1725—*Platforms and Other Facilities*), operators need to remove seafloor obstructions from their leases within 1 year of lease termination or after a structure has been deemed obsolete or unusable. These regulations also require the operator to sever bottom-founded objects and their related components at least 5 m (15 ft) below the mudline (30 CFR 250.1716(a)—*Wellheads/Casings* and 30 CFR 250.1728(a)—*Platforms and Other Facilities*). The severance operations are generally categorized as explosive or nonexplosive.

Chapter 1.5 describes regulations, reporting guidelines, and specific mitigation measures developed through consultation, pursuant to Section 7 of the ESA and the MMPA, concerning potential impacts on endangered and threatened species associated with explosive severance activities conducted during the structure-removal operations. All of the current terms and conditions of structure and well removal activities are outlined in NTL 2010-G05, "Decommissioning Guidance for Wells and Platforms," which became effective on October 15, 2010.

Marine Protected Species NTL's

Three NTL's that were issued in 2007 advise operators of measures designed to reduce impacts to Marine Protected Species: NTL 2007-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program"; NTL 2007-G03, "Marine Trash and Debris Awareness and Elimination"; and NTL 2007-G04, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting." The provisions outlined in these NTL's apply to all existing and future oil and gas operations in the Gulf of Mexico OCS.

The NTL 2007-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," provides guidance to protect marine mammals and sea turtles during seismic operations. This NTL clarifies how operators 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 in this NTL apply to all on-lease surveys conducted under 30 CFR 250 and to all off-lease surveys conducted under 30 CFR 251.

The NTL 2007-G03, "Marine Trash and Debris Awareness and Elimination," provides guidance to prevent intentional and/or accidental introduction of debris into the marine environment. Operators are prohibited from deliberately discharging containers and other similar materials (i.e., trash and debris) into the marine environment (30 CFR 250.300(a) and (b)(6)) and are required to make durable identification markings on equipment, tools, containers (especially drums), and other material (30 CFR 250.300(c)). The intentional jettisoning of trash has been the subject of strict laws such as the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V and the Marine Plastic Pollution Research and Control Act, and regulations imposed by various agencies including USCG and USEPA. These USCG and USEPA regulations require that operators become more proactive in avoiding accidental loss of solid-waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. The NTL 2007-G03 states marine debris placards must be posted in prominent places on all fixed and floating production facilities that have sleeping or food preparation capabilities and on mobile drilling units. Operators must also ensure that all of their offshore employees and those contractors actively engaged in their offshore operations complete annual training that includes (1) viewing a training video or slide show (specific options are outlined in the NTL) and (2) receiving an explanation from the lessee company's management that emphasizes their commitment to the NTL's provisions. An annual report that describes the marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year is to be provided to BSEE by January 31 of each year.

The NTL 2007-G04, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," explains how operators must implement measures to minimize the risk of vessel strikes to protected species and report observations of injured or dead protected species. Vessel operators and crews must maintain a vigilant watch for marine protected species and slow down or stop their vessel to avoid striking protected species. Crews must report sightings of any injured or dead protected species (marine mammals and sea turtles) immediately, regardless of whether the injury or death is caused by their vessel, to the Marine Mammal and Sea Turtle Stranding Hotline or the Marine Mammal Stranding Network. In addition, if it was the operator's vessel that collided with a protected species, BSEE must be notified within 24 hours of the strike.

Rigs-to-Reefs

Rigs-to-Reefs (RTR) is a term for converting obsolete, nonproductive offshore oil and gas platforms to designated artificial reefs (Dauterive, 2000). Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry but it can be a loss of productive marine habitat. The use of obsolete oil and gas platforms for reefs has proven to be highly successful. Their availability, design profile, durability, and stability provide a number of advantages over the use of traditional artificial reef materials. To capture this valuable fish habitat, the States of Louisiana, Texas, and Mississippi, in 1986, 1989, and 1999, respectively, passed enabling legislation and signed into law a RTR program to coincide with their respective States' Artificial Reef Plan. Alabama and Florida have no RTR legislation. The State laws set up a mechanism to transfer ownership and liability of the platform from oil and gas companies to the State when the platform ceases production and the lease is terminated. The company (donor) saves money by donating a platform to the State (recipient) for a reef rather than scrapping the platform onshore. The industry then donates 50 percent of the savings to the State, which is put toward the State's artificial reef program. Since the inception of the RTR program, more than 400 retired platforms have been donated and used as reefs in the Gulf of Mexico.

1.6. OTHER OCS-RELATED ACTIVITIES

The BOEM and the BSEE have programs and activities that are OCS related but not specific to the oil and gas leasing process or to the management of exploration, development, and production activities. These programs include both environmental and technical studies, and cooperative agreements with other Federal and State agencies for NEPA work, joint jurisdiction over cooperative efforts, inspection activities, and regulatory enforcement. The BOEM also participates in industry research efforts and forums.

Environmental Studies Program

The Environmental Studies Program (ESP) was established in 1973 in accordance with Section 20 of the OCSLA. The goals of the ESP are to obtain environmental and socioeconomic information that can be used to assess the potential and real effects of the Gulf of Mexico OCS natural gas and oil program. As a part of the ESP, the Gulf of Mexico OCS Region has funded more than 875 completed or ongoing environmental studies. The types of studies funded include

- literature reviews and baseline studies of the physical, chemical, and biological environment of the shelf;
- literature review and studies of the physical, chemical, and biological environment of deep water >300 m (1,000 ft);
- studies of the socioeconomic impacts along the Gulf Coast; and
- studies of the effects of oil and gas activities on the marine environment.

A list of the Gulf of Mexico OCS Region's studies published from 2006 to the present is presented in **Appendix H**. Studies completed since 1974 will be available on the BOEM, Gulf of Mexico OCS Region's Internet website under "Environmental Stewardship, Environmental Studies." The BOEM's Environmental Studies Program Information System (ESPIS) provides immediate access to all completed BOEM studies. The ESPIS is a searchable, web-based, full-text retrieval system allowing users to view online or to download the complete text of any completed ESP report. A complete list of all ongoing Gulf of Mexico OCS Region studies is available on the BOEM Internet website. Each listing not only describes the research being conducted but also shows the institution performing the work, the cost of the effort, timeframe, and any associated publications, presentations, or affiliated websites.

The ESP funds studies to obtain information needed for NEPA assessment and the management of environmental and socioeconomic impacts on the human, marine, and coastal environments that may be affected by OCS oil and gas development. The ESP studies were used by BOEM's Gulf of Mexico OCS Region analysts to prepare this document. While not all of the Gulf of Mexico OCS Region's studies are specifically referenced in this document, they were used by analysts as input into their analyses. The information in ESP studies is also used by decisionmakers to manage and regulate exploration, development, and production activities on the OCS.

Technology Assessment & Research Program

The Technology Assessment & Research (TA&R) Program supports research associated with operational safety and pollution prevention as well as oil-spill response and cleanup capabilities. The TA&R Program is comprised of two functional research activities: (1) operational safety and engineering research (topics such as air quality, decommissioning, and mooring and anchoring); and (2) oil-spill research (topics such as behavior of oil, chemical treating agents, and in situ burning of oil). The TA&R Program has four primary objectives.

- Technical Support—Providing engineering support in evaluating industry operational proposals and related technical issues and in ensuring that these proposals comply with applicable regulations, rules, and operational guidelines and standards.
- Technology Assessment—Investigating and assessing industry applications of technological innovations and ensuring that governing BSEE regulations, rules, and operational guidelines ensure the use of BAST (**Chapter 1.5**, "New and Unusual Technology").
- Research Catalyst—Promoting and participating in industry research initiatives in the fields of operational safety, engineering research, and oil-spill response and cleanup research.
- International Regulations—Supporting international cooperative efforts for research and development initiatives to enhance the safety of offshore oil and natural gas activities and the development of appropriate regulatory program elements worldwide.

Interagency Agreements

Memoranda of Understanding under NEPA

Section 1500.5(b) of the CEQ implementing regulations (40 CFR 1500.5(b)) encourages agency cooperation early in the NEPA process. A Federal agency can be a lead, joint lead, or cooperating agency. A lead agency manages the NEPA process and is responsible for the preparation of an EIS; a joint lead agency shares these responsibilities; and a cooperating agency that has jurisdiction by law and has special expertise with respect to any environmental issue shall participate in the NEPA process upon the request of the lead agency.

When an agency becomes a Cooperating Agency, the cooperating and lead agencies usually enter into an MOU, previously called a Cooperating Agency Agreement. The Agreement details the responsibilities of each participating agency. The BOEM, as lead agency, has requested other Federal agencies to become cooperating agencies while other agencies have requested BOEM to become a cooperating agency (e.g., the Ocean Express Pipeline project). Some projects, such as major gas pipelines across Federal waters and projects under the Deepwater Port Act of 1974, can require cooperative efforts by multiple Federal and State agencies.

The NOI included an invitation to other Federal agencies and State, tribal, and local governments to consider becoming cooperating agencies in the preparation of this EIS. Consultation and coordination activities for this EIS are described in **Chapter 5**.

Memorandum of Understanding and Memoranda of Agreements between MMS (BOEM/BSEE) and USCG

Since BSEE and USCG have closely related jurisdiction over different aspects of safety and operations on the OCS, the agencies have established a formal MOU that delineates lead responsibilities for managing OCS activities in accordance with the OCSLA, as amended, and OPA. The latest MOU, dated September 30, 2004, supersedes the August 1989 and December 1998 versions of the interagency agreement. The MOU is designed to minimize duplication and promote consistent regulation of facilities under the jurisdiction of both agencies. A Memorandum of Agreement (MOA), OCS No. 1—Agency Responsibilities, between BSEE and USCG, dated September 30, 2004, further clarifies the technical and process section of the BSEE/USCG MOU. The MOA requires the participating agencies to review their internal procedures and, where appropriate, revise them to accommodate the provisions of the September 2004 MOA. To facilitate coordination with USCG, BSEE has established a full-time position within the Office of Offshore Regulatory Programs to provide liaison between the agencies.

Generally, the MOU identifies BSEE as the lead agency for matters concerning the equipment and operations directly involved in the production of oil and gas. These include, among others, design and operation of risers, permanent mooring foundations of the facility, drilling and well production and services, inspection and testing of all drilling-related equipment, and platform decommissioning. Issues regarding certain aspects of safe operation of the facility, its systems, and equipment generally fall under the jurisdiction of USCG. These include, among others, design of vessels, their sea-keeping characteristics, propulsion and dynamic positioning systems, supply and lightering procedures and equipment, utility systems, safety equipment and procedures, and pollution prevention and response procedures. In 2002, this Agency was authorized to inspect USCG-related safety items on fixed facilities on the OCS.

Generally, the MOA identifies agency responsibilities (i.e., agency representatives for the purpose of keeping each other informed of issues, relevant applications, routine policy determinations and to coordinate joint activities), civil penalties (i.e., USCG refers civil penalty cases to BSEE), OSFR (i.e., BSEE determines and provides OSFR-related information to USCG upon request), oil-spill preparedness and response planning (i.e., BSEE requires responsible parties to maintain approved oil-spill-response plans consistent with Area Contingency Plans and the National Contingency Plan), oil-spill response (i.e., reporting all spills to the National Response Center and direct measures to abate sources of pollution from an OCS facility), accident investigations (i.e., BSEE and USCG responsible for investigating and preparing report of fires, spillage, injury, fatality and blowouts and collisions and allisions), and offshore facility system/subsystem responsibility matrix (identifies lead agency responsible for MODU, fixed, and floating systems and subsystems, and coordinates with other agencies as appropriate).

On April 18, 2005, this Agency and USCG met to identify MOA’s that needed to be developed and to prioritize work. The following subject areas were selected: (a) civil penalties; (b) incident investigations; (c) offshore security; (d) oil-spill planning, preparedness, and response; (e) deepwater ports; (f) digital databases; (g) MODU’s; (h) fixed platforms; (i) floating platforms; (j) floating, production, storage, and offloading units (FPSO’s); and (k) incident reporting. Joint agency teams have been established to develop the MOA’s for the first five subject areas. In addition, an MOA is also being pursued to address renewable energy and alternate use of the OCS. The Civil Penalties MOA-OCS-02 was approved on September 12, 2006. The Oil Discharge Planning, Preparedness, and Response MOA-OCS-03 became effective on May 23, 2009, and the Incident Investigation MOA-OCS-03 became effective on March 27, 2009.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

2. ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

2.1. MULTISALE NEPA ANALYSIS

As authorized under 40 CFR 1502.4, one EIS is allowed to analyze related or similar proposals. This EIS addresses five areawide oil and gas lease sales in the WPA and five areawide oil and gas lease sales in the CPA of the Gulf of Mexico OCS (**Figure 1-1**), as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017* (5-Year Program).

For analysis purposes, a proposed action is presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors for the WPA and CPA sale areas. Each of the proposed lease sales in a sale area is expected to be within the scenario ranges for the sale area; therefore, a WPA proposed action is representative of proposed WPA Lease Sales 229, 233, 238, 246, and 248; and a CPA proposed action is representative of proposed CPA Lease Sales 227, 231, 235, 241, and 247. Each proposed action includes existing regulations and lease stipulations. This EIS will be the only NEPA document prepared for proposed WPA Lease Sale 229 and proposed CPA Lease Sale 227. An additional NEPA review will be conducted for each subsequent proposed lease sale in the 5-Year Program.

The Multisale EIS approach is intended to focus the NEPA/EIS process on the differences between the proposed lease sales and new issues and information. It also lessens duplication and saves resources. The scoping process for this document is described in **Chapters 1.4 and 5.3.** As mandated by NEPA, this EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments.

This EIS will be the final NEPA review conducted for proposed WPA Lease Sale 229 and proposed CPA Lease Sale 227. An additional NEPA review (an environmental assessment (EA), or if determined necessary, a supplemental EIS) will be conducted prior to each of the eight remaining proposed lease sales to address any relevant new information. Informal and formal consultations with other Federal agencies, the affected States, and the public will be carried out to assist in the determination of whether or not the information and analyses in this EIS are still valid. Specifically, information requests will be issued soliciting input on subsequent proposed lease sales.

Any subsequent EA's will tier from this Multisale EIS and will summarize and incorporate the material by reference. Because any subsequent EA's will be prepared for a proposal that "is, or is closely similar to, one which normally requires the preparation of an EIS" (40 CFR 1501.4(e)(2)), the EA will be made available for public review for a minimum of 30 days prior to making a decision on the proposed lease sale. Consideration of the EA and any comments received in response to the Information Request will result in either a Finding of No New Significant Impacts (FONNSI) or the determination that the preparation of a supplemental EIS is warranted. If the EA results in a FONNSI, the EA and FONNSI will be sent to the Governors of the affected States. The availability of the EA and FONNSI will be announced in the *Federal Register*. The FONNSI will become part of the documentation prepared for the decision on the Notice of Sale.

In some cases, the EA may result in a finding that it is necessary to prepare a Supplemental EIS (40 CFR 1502.9). Some of the factors that could justify a Supplemental EIS are a significant change in resource estimates, significant new information, significant new environmental issue(s), new proposed alternative(s), a significant change in the proposed action, or the analysis in this Multisale EIS is no longer deemed adequate.

If a Supplemental EIS is necessary, it will also tier from this Multisale EIS and will summarize and incorporate the material by reference. The analysis will focus on addressing the new issue(s) and/or concern(s) that were noted in the EA. The Supplemental EIS will include a discussion of the purpose of the Supplemental EIS, a description of the proposed action and alternatives, a comparison of the proposed alternatives, a description of the affected environment, potentially affected resources, an analysis of new impacts, and new information not addressed in the Multisale EIS. The Supplemental EIS will also include an updated discussion of associated BOEM coordination and consultations.

2.2. ALTERNATIVES, MITIGATING MEASURES, AND ISSUES

2.2.1. Alternatives

2.2.1.1. Alternatives for Proposed Western Planning Area Lease Sales 229, 233, 238, 246, and 248

Alternative A—The Proposed Action: This is BOEM's preferred alternative. This alternative would offer for lease all unleased blocks within the WPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(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 nmi north of the continental shelf boundary between the U.S. and Mexico.

The WPA sale area encompasses about 28.6 million ac. Approximately 21.2 million ac of the WPA sale area is currently unleased. The estimated amount of resources projected to be developed as a result of the proposed WPA lease sale is 0.116-0.200 BBO and 0.538-0.938 Tcf of gas (**Table 3-1**).

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, 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 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 WPA lease sale would not occur or would be postponed. This is also analyzed in the EIS for the 5-Year Program on a nationwide programmatic level.

Alternatives Considered but Not Analyzed

Limit Leasing to Shallow Waters

During scoping for the 2012-2017 5-Year Program, BOEMRE received comments stating opposition to drilling in deep waters and requesting that we consider an alternative that would limit leasing to shallow waters. One person who commented supported drilling in water depths <1,000 ft (305 m) but not at greater depths. The 1,000-ft (305-m) depth has been often used in the past when referring to deep water. It appears that the person offering the comment is requesting such a leasing alternative due to concerns regarding the risks of blowouts and oil spills from drilling in deep water versus drilling at shallower depths. Such concerns have been heightened since the DWH event.

Blowouts are a subset of "loss of well control" events that BOEM tracks. The current definition for loss of well control is as follows:

- uncontrolled flow of formation or other fluids (the flow may be to an exposed formation [an underground blowout] or at the surface [a surface blowout]);
- uncontrolled flow through a diverter; and/or
- uncontrolled flow resulting from a failure of surface equipment or procedures.

Not all loss of well control events result in blowouts as defined above; not all events may result in a release to the human environment. In common usage, a blowout is thought of as a release to the human environment. Blowouts and spills occur in both shallow and deepwater drilling environments. **Table 2-1** shows the most recent loss of well control statistics from 2006 to 2010 by water depth. Of the 27 total incidents, only 6 occurred in water depths >500 ft (152 m); that is, 21 of 27 loss of well control incidents (77%) occurred in water depths <500 ft (152 m).

Table 2-2 shows the number of wells drilled, the number of blowout incidents, and blowout rates by water depth. From 1992 to 2006, 39 blowouts occurred at a rate of one blowout for every 387 wells drilled (10%). Between 1992 and 2006 most blowouts (33 out of 39, or 84%) occurred during well drilling in water depths ≤500 ft (152 m) deep (**Table 2-2**; Izon et al., 2007, Table 1).

In this section, blowouts are considered synonymous with a "loss of well control" event. The number of blowouts reported to BOEM is down from the previous 21-year period (1971-1991), where 87 blowouts occurred at a rate of one blowout for every 246 wells drilled (35%). Between 1971 and 1991 most blowouts (77 out of 87, or 89%) occurred during well drilling in water depths ≤500 ft (152 m) (**Table 2-2**; Danenberger, 1993, Table 1).

Table 2-2 identifies loss of well control incidents, as BOEM currently tracks, i.e., blowouts per wells drilled (Izon et al.,2007; Danenberger, 1993). **Table 2-2** shows a strong trend to incidents in shallow water. The perception that shallow-water drilling is somehow safer is not borne out by the data.

The potential environmental impacts associated with blowouts varies depending on the location, duration, and water depth of the incident, as well as whether or not the blowout results in the release of gas, oil, or both. The most serious of all impacts, human injury or fatality, can occur with blowouts, regardless of water depth. As evidence of an improved trend in safety, only one fatality and two injuries related to blowouts occurred from 1992 to 2006, compared with 25 fatalities and 61 injuries for the 1971-1991 time period.

With respect to oil spills, the potential for a blowout to result in a large oil spill may be greater in deep water than in shallow water because BOEM resource assessment studies show a higher probability of large oil reservoirs being discovered in deep water as compared with shallow water. It is believed that most of the largest GOM oil reservoirs in shallow water areas at drill depths of <15,000 ft (4,572 m) beneath the seafloor have been identified. Large undiscovered hydrocarbon reservoirs are still thought to exist in the shallow water areas of the CPA and WPA; however, results taken from BOEM's most recent resource assessment study and a review of the more recent shallow-water drilling and leasing activity suggest that future discoveries of large reservoirs in the shallow water areas of the GOM are likely to exist at drilling depths >15,000 ft (4,572 m) below the seafloor where geologic conditions are more favorable for natural gas reservoirs to exist than oil reservoirs. It is important to note, however, that the *Ixtoc* spill in 1979 in Mexico's Bay of Campeche spilled 3.3 million bbl of oil over a period of 290 days; that spill occurred in only 164 ft of water.

In recent years, deepwater drilling to depths beneath the seafloor (~30,000 ft) is occurring on the shelf in very shallow waters. At such depths, very high temperatures (HT) and high pressures (HP) are encountered. The so called HTHP drilling environment is a challenge to the basic metallurgy of equipment as well as to the ability to operate it from the surface that constitutes a serious blowout risk. In summary, there is some level of risk associated with drilling, regardless of water depth that is not lessened by simply operating in shallower water.

A deepwater spill would generally occur farther from shore than a shallow-water spill. Although it may be more difficult to respond to and cleanup a deepwater spill, it would also take longer for oil to reach sensitive coastal habitats. It is also more likely that dispersants would be applied to deepwater, offshore spills, thereby reducing the potential for onshore impacts. Distance from shore is a proxy measure for residence time that a spill remains at sea; the farther from shore generally the longer it takes for currents and waves to carry it to shore. From the moment oil is released at sea, it begins to weather and degrade. A shallow-water spill would occur closer to shore. Although it would be easier to respond to and cleanup a spill in shallow water, it would take less time for the initial spill and remaining oil to reach the shore.

The key to managing risk, however, is not to limit leasing in deep versus shallow waters (or vice-versa). The key to managing risk is to implement a rigorous regulatory regime to ensure that postlease drilling activities are conducted in a safe manner. The BOEM has implemented a suite of regulatory changes following the DWH event. These are discussed in detail in **Chapters 1.3.1 and 3.2.2**. The appropriate time to conduct detailed geophysical and engineering reviews, which would identify risks, is at the postlease stage when exploration and development plans are submitted to BOEM for review. It is at this stage that detailed information regarding the specific proposed action is available for review, including reservoir characteristics, infrastructure designs, and features to ensure safety and reduce environmental risk. As a result of BOEM's review, modifications to these individual plans to increase safety and to reduce the potential for accidental events should be made conditions of plan approval by BOEM and should be followed up by rigorous inspection and enforcement activities.

The need for the WPA and CPA proposed actions (10 areawide lease sales in the GOM; 5 each in the WPA and CPA) is to further the orderly development of OCS resources. The U.S. consumed 19.5 million bbl of oil per day in 2009 (USDOE, Energy Information Administration, 2010a). Altogether, net imports of crude oil and petroleum products (imports minus exports) accounted for 51 percent of our total petroleum consumption in 2009. The U.S. crude oil imports stood at 9.0 million bbl per day in 2009. Increased domestic production is needed to reduce our dependency on foreign oil.

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 by developing those resources in a manner consistent with environmental protection and the laws and policies of affected States. Over the last 20 years, leasing, drilling, and production has moved steadily into deeper waters. As of July 6, 2011, there were approximately 6,141 active leases on the Gulf of Mexico OCS in water depths >1,000 ft (305 m).

A shallow-water only lease sale would result in a scenario where there would be little to no change in the assessment of potential environmental damage and safety concerns on the OCS; however, there would be significant adverse effects to the economic benefits of a shallow-water only lease sale. Not offering deepwater OCS blocks in a sale or a few sales would indeed reduce the exploration and development (E&D) activity on blocks leased in those sales, but the cumulative (all leases) effect on E&D activity in the GOM would not change very much, if at all. This because the E&D activity that would have been focused on any deepwater blocks leased in a typical areawide lease sale would simply be refocused to the more than 4,000 undrilled leases currently held by industry in the deepwater GOM today. However, attention to currently held leases does not ensure that these leases will be drilled. The undrilled leases held by the oil and gas industry provide an exploration prospect portfolio from which a company can decide which prospect best fits into their exploratory drilling strategy, which for large, integrated operators exist in an inventory of worldwide prospects. The strategy is, in part, based on risk tolerance and expected rate of return on investment. Essentially, a company will drill the best prospect in their worldwide portfolio. Companies active in the GOM continuously explore for new prospects to add to their portfolio by acquiring and interpreting geophysical, geological, and engineering data, and leasing availability of OCS blocks at BOEM lease sales, which until recently, were held on a regular basis.

A hiatus in lease offerings of a year or two and the extension of certain lease terms on existing leases, coupled with a significant downturn in exploration drilling, has not degraded the quality or quantity of company exploration portfolios and will therefore not detract companies from resuming drilling activity in the GOM once the full opportunity to drill is offered. However, over time this cannot be sustained. If none of the 10 proposed lease sales in the 2012-2017 5-Year Program included deepwater OCS blocks, a downturn in cumulative E&D activity would be realized.

In addition, if BOEM were to offer new leases only in shallow-water areas of the GOM, it is likely that there may be a slight, possibly even measurable, increase in leasing and E&D activity in the shallow-water areas of the GOM. This may result in a greater number of platforms, wells drilled, and miles of pipeline installed closer to shore and closer to sensitive environmental resources along the Gulf Coast.

Based on the information presented above, BOEM has determined that an alternative that would allow leasing only in shallow water will not decrease the risk associated with deepwater drilling, may place coastal resources at increased risk, and may be detrimental to the recovery of OCS oil and gas resources in the long term. It does not meet the purpose and need for the WPA and CPA proposed actions and, therefore, it has not been retained for detailed analysis in this EIS.

2.2.1.2. Alternatives for Proposed Central Planning Area Lease Sales 227, 231, 235, 241, and 247

Alternative A—The Proposed Action: This is BOEM's preferred alternative. This alternative would offer for lease all unleased blocks within the CPA for oil and gas operations (**Figure 2-1),** with the following exceptions:

(1) blocks that were previously included within the Gulf of Mexico's EPA and are within 100 mi (161 km) of the Florida coast;

(2) blocks east of the Military Mission line (86 degrees, 41 minutes West longitude) under an existing moratorium 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 a proposed CPA lease sale is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas **(Table 3-1)**.

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 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 CPA lease sale. 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 CPA lease sale would not occur or would be postponed. This is also analyzed in the EIS for the 5-Year Program on a nationwide programmatic level.

Alternatives Considered but Not Analyzed

Limit Leasing to Shallow Waters

During scoping for the 2012-2017 5-Year Program, BOEMRE received comments indicating opposition to drilling in deep waters and requests that we consider an alternative that would limit leasing to shallow waters. One person who commented supported drilling in water depths <1,000 ft (305 m) but not at greater depths. The 1,000-ft (305-m) depth has been often used in the past when referring to deep water. It appears that the person offering the comment is requesting such a leasing alternative due to concerns regarding the risks of blowouts and oil spills from drilling in deep water versus drilling at shallower depths. Such concerns have been heightened since the DWH event.

Blowouts are a subset of "loss of well control" events that BOEM tracks. The current definition for loss of well control is as follows:

- uncontrolled flow of formation or other fluids (the flow may be to an exposed formation [an underground blowout] or at the surface [a surface blowout]);
- uncontrolled flow through a diverter; and/or
- uncontrolled flow resulting from a failure of surface equipment or procedures.

Not all loss of well control events result in blowouts as defined above; not all events may result in a release to the human environment. In common usage, a blowout is thought of as a release to the human environment. Blowouts and spills occur in both shallow and deepwater drilling environments. **Table 2-1** shows the most recent loss of well control statistics from 2006 to 2010 by water depth. Of the 27 total incidents, only 6 occurred in water depths >500 ft (152 m); that is, 21 of 27 loss of well control incidents (77%) occurred in water depths <500 ft (152 m).

Table 2-2 shows the number of wells drilled, the number of blowout incidents, and blowout rates by water depth. From 1992 to 2006, 39 blowouts occurred at a rate of one blowout for every 387 wells drilled (10%). Between 1992 and 2006 most blowouts (33 out of 39, or 84%) occurred during well drilling in water depths ≤500 ft (152 m) deep (**Table 2-2**; Izon et al., 2007, Table 1).

In this section, blowouts are considered synonymous with a "loss of well control" event. The number of blowouts reported to BOEM is down from the previous 21-year period (1971-1991), where 87 blowouts occurred at a rate of one blowout for every 246 wells drilled (35%). Between 1971 and 1991 most blowouts (77 out of 87, or 89%) occurred during well drilling in water depths ≤500 ft (152 m) (**Table 2-2**; Danenberger, 1993, Table 1).

Table 2-2 identifies loss of well control incidents, as BOEM currently tracks, i.e., the blowouts and per wells drilled (Izon et al. (2007; Danenberger, 1993). **Table 2-2** shows a strong trend to incidents in shallow water. The perception that shallow-water drilling is somehow safer is not borne out by the data.

The potential environmental impacts associated with blowouts varies depending on the location, duration, and water depth of the incident, as well as whether or not the blowout results in the release of gas, oil, or both. The most serious of all impacts, human injury or fatality, can occur with blowouts, regardless of water depth. As evidence of an improved trend in safety, only one fatality and two injuries related to blowouts occurred from 1992 to 2006, compared with 25 fatalities and 61 injuries for the 1971-1991 time period.

With respect to oil spills, the potential for a blowout to result in a large oil spill may be greater in deep water than in shallow water because BOEM resource assessment studies show a higher probability of large oil reservoirs being discovered in deep water as compared with shallow water. It is believed that most of the largest GOM oil reservoirs in shallow water areas at drill depths of <15,000 ft (4,572 m) beneath the seafloor have been identified. Large undiscovered hydrocarbon reservoirs are still thought to exist in the shallow water areas of the CPA and WPA; however, results taken from BOEM's most recent resource assessment study and a review of the more recent shallow-water drilling and leasing activity suggest that future discoveries of large reservoirs in the shallow water areas of the GOM are likely to exist at drilling depths >15,000 ft (4,572 m) below the seafloor where geologic conditions are more favorable for natural gas reservoirs to exist than oil reservoirs. It is important to note, however, that the *Ixtoc* spill in 1979 in Mexico's Bay of Campeche spilled 3.3 million bbl of oil over a period of 290 days; that spill occurred in only 164 ft of water.

In recent years, deepwater drilling to depths beneath the seafloor (~30,000 ft) is occurring on the shelf in very shallow waters. At such depths, very high temperatures (HT) and high pressures (HP) are encountered. The so called HTHP drilling environment is a challenge to the basic metallurgy of equipment as well as to the ability to operate it from the surface that constitutes a serious blowout risk. In summary, there is some level of risk associated with drilling, regardless of water depth that is not lessened by simply operating in shallower water.

A deepwater spill would generally occur farther from shore than a shallow-water spill. Although it may be more difficult to respond to and cleanup a deepwater spill, it would also take longer for oil to reach sensitive coastal habitats. It is also more likely that dispersants would be applied to deepwater, offshore spills, thereby reducing the potential for onshore impacts. Distance from shore is a proxy measure for residence time that a spill remains at sea; the farther from shore generally the longer it takes for currents and waves to carry it to shore. From the moment oil is released at sea, it begins to weather and degrade. A shallow-water spill would occur closer to shore. Although it would be easier to respond to and cleanup a spill in shallow water, it would take less time for the initial spill and remaining oil to reach the shore.

The key to managing risk, however, is not to limit leasing in deep versus shallow waters (or vice-versa). The key to managing risk is to implement a rigorous regulatory regime to ensure that postlease drilling activities are conducted in a safe manner. The BOEM has implemented a suite of regulatory changes following the DWH event. These are discussed in detail in **Chapters 1.3.1 and 3.2.2**. The appropriate time to conduct detailed geophysical and engineering reviews, which would identify risks, is at the postlease stage when exploration and development plans are submitted to BOEM for review. It is at this stage that detailed information regarding the specific proposed action is available for review, including reservoir characteristics, infrastructure designs, and features to ensure safety and reduce environmental risk. As a result of BOEM's review, modifications to these individual plans to increase safety and to reduce the potential for accidental events should be made conditions of plan approval by BOEM and should be followed up by rigorous inspection and enforcement activities.

The need for the WPA and CPA proposed actions (10 areawide lease sales in the GOM; 5 each in the WPA and CPA) is to further the orderly development of OCS resources. The U.S. consumed 19.5 million bbl of oil per day in 2009 (USDOE, Energy Information Administration, 2010a). Altogether, net imports of crude oil and petroleum products (imports minus exports) accounted for 51 percent of our total petroleum consumption in 2009. The U.S. crude oil imports stood at 9.0 million bbl per day in 2009. Increased domestic production is needed to reduce our dependency on foreign oil.

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 by developing those resources in a manner consistent with environmental protection and the laws and policies of affected States. Over the last 20 years, leasing, drilling, and production has moved steadily into deeper waters. As of July 6, 2011, there were approximately 6,141 active leases on the Gulf of Mexico OCS in water depths >1,000 ft (305 m).

A shallow-water only lease sale would result in a scenario where there would be little to no change in the assessment of potential environmental damage and safety concerns on the OCS; however, there would be significant adverse effects to the economic benefits of a shallow-water only lease sale. Not offering deepwater OCS blocks in a sale or a few sales would indeed reduce the E&D activity on blocks leased in those sales, but the cumulative (all leases) effect on E&D activity in the GOM would not change very much, if at all. This because the E&D activity that would have been focused on any deepwater blocks leased in a typical areawide lease sale would simply be refocused to the more than 4,000 undrilled leases currently held by industry in the deepwater GOM today. However, attention to currently held leases does not ensure that these leases will be drilled. The undrilled leases held by the oil and gas industry provide an exploration prospect portfolio from which a company can decide which prospect best fits into their exploratory drilling strategy, which for large, integrated operators exist in an inventory of worldwide prospects. The strategy is, in part, based on risk tolerance and expected rate of return on investment. Essentially, a company will drill the best prospect in their worldwide portfolio. Companies active in the GOM continuously explore for new prospects to add to their portfolio by acquiring and interpreting geophysical, geological, and engineering data, and leasing availability of OCS blocks at BOEM lease sales, which until recently, were held on a regular basis.

A hiatus in lease offerings of a year or two and the extension of certain lease terms on existing leases, coupled with a significant downturn in exploration drilling, has not degraded the quality or quantity of company exploration portfolios and will therefore not detract companies from resuming drilling activity in the GOM once the full opportunity to drill is offered. However, over time this cannot be sustained. If none of the 10 proposed lease sales in the 2012-2017 5-Year Program included deepwater OCS blocks, a downturn in cumulative E&D activity would be realized.

In addition, if BOEM were to offer new leases only in shallow-water areas of the GOM, it is likely that there may be a slight, possibly even measurable, increase in leasing and E&D activity in the shallow-water areas of the GOM. This may result in a greater number of platforms, wells drilled, and miles of pipeline installed closer to shore and closer to sensitive environmental resources along the Gulf Coast.

Based on the information presented above, BOEM has determined that an alternative that would allow leasing only in shallow water will not decrease the risk associated with deepwater drilling, may place coastal resources at increased risk, and may be detrimental to the recovery of OCS oil and gas resources in the long term. It does not meet the purpose and need for the WPA and CPA proposed actions and, therefore, it has not been retained for detailed analysis in this EIS.

2.2.2. Mitigating Measures

The NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences and to take actions that protect, restore, and enhance the environment. Agencies are required to identify and include in the alternative chosen relevant and reasonable mitigation measures that could improve the action. Section 1508.20 of the CEQ regulations define mitigation as

- Avoidance—Avoiding an impact altogether by not taking a certain action or part of an action.
- Minimization—Minimizing impacts by limiting the intensity or magnitude of the action and its implementation.

- Restoration—Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Maintenance—Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensation—Compensating for the impact by replacing or providing substitute resources or environments.

2.2.2.1. Proposed Mitigating Measures Analyzed

The potential mitigating measures included for analysis in this Multisale EIS were developed as a result of numerous scoping efforts for the continuing OCS Program in the Gulf of Mexico. Four lease stipulations (described in **Chapter 2.3.1.3**) are proposed for WPA Lease Sales 229, 233, 238, 246, and 248—the Topographic Features Stipulation, the Military Areas Stipulation, the Protected Species Stipulation, and the Law of the Sea Convention Royalty Payment Stipulation. The Naval Mine Warfare Area Stipulation is no longer applicable to the proposed WPA lease sale area by memorandum dated April 3, 2009, from the Department of the Navy. Eight lease stipulations (described in **Chapter 2.4.1.3**) are proposed for the CPA Lease Sales 227, 231, 235, 241, and 247—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; and the Law of the Sea Convention Royalty Payment Stipulation. The Law of the Sea Convention Royalty Payment Stipulation is applicable to the proposed WPA and CPA lease sales even though it is not an environmental or military stipulation.

These measures will be considered for adoption by the ASLM, under authority delegated by the Secretary of the Interior. The analysis of any stipulations for Alternative A does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from any 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 change.

Any stipulations or mitigation requirements to be included in a lease sale will be described in the ROD for that lease sale. Mitigating measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease. In addition, each exploration and development plan, as well as any pipeline applications that result from a lease sale, will undergo a NEPA review, and additional project-specific mitigations applied as conditions of plan approval. The BSEE has the authority to monitor and enforce these conditions, and under 30 CFR 250 Subpart N, may seek remedies and penalties from any operator that fails to comply with those conditions, stipulations, and mitigating measures.

2.2.2.2. Existing Mitigating Measures

This section discusses mitigating measures that would be applied by BOEM. Mitigating measures have been proposed, identified, evaluated, or developed through previous BOEM lease sale NEPA review and analysis. Many of these mitigating measures have been adopted and incorporated into regulations and/or guidelines governing OCS exploration, development, and production activities. All plans for OCS activities (e.g., exploration and development plans, pipeline applications, and structure-removal applications) go through rigorous BOEM review and approval to ensure compliance with established laws and regulations. Existing mitigating measures must be incorporated and documented in plans submitted to BOEM. Operational compliance of the mitigating measures is enforced through BSEE's onsite inspection program.

Mitigating measures are a standard part of BOEM's program to ensure that the operations are always conducted in an environmentally sound manner (with an emphasis on minimizing any adverse impact of routine operations on the environment). For example, certain measures ensure site clearance, and survey procedures are carried out to determine potential snags to commercial fishing and avoidance of archaeological sites and biologically sensitive areas such as pinnacles, topographic features, and chemosynthetic communities.

Some BOEM-identified mitigating measures are incorporated into OCS operations through cooperative agreements or efforts with industry and State and Federal agencies. These mitigating measures include NMFS's Observer Program to protect marine mammals and sea turtles during explosive removals, labeling operational supplies to track possible sources of debris or equipment loss, development of methods of pipeline landfall to eliminate impacts to beaches or wetlands, and beach cleanup events.

Site-specific mitigating measures are also applied by BOEM during plan and permit reviews. The BOEM realized that many of these site-specific mitigations were recurring and developed a list of "standard" mitigations. There are currently over 120 standard mitigations. The wording of a standard mitigation is developed by BOEM in advance and may be applied whenever conditions warrant. Standard mitigation text is revised as often as is necessary (e.g., to reflect changes in regulatory citations, agency/personnel contact numbers, and internal policy). Site-specific mitigation "categories" include the following: air quality; archaeological resources; artificial reef material; chemosynthetic communities; Flower Garden Banks; topographic features; hard bottoms/pinnacles; military warning areas and Eglin Water Test Areas (EWTA's); hydrogen sulfide; drilling hazards; remotely operated vehicle surveys; geophysical survey reviews; and general safety concerns. Site-specific mitigation "types" include the following: advisories; conditions of approval; hazard survey reviews; inspection requirements; notifications; post-approval submittals; and safety precautions. In addition to standard mitigations, BOEM may also apply nonrecurring mitigating measures that are developed on a case-by-case basis.

The BOEM is continually revising applicable mitigations to allow the Gulf of Mexico Region to more easily and routinely track mitigation compliance and effectiveness. A primary focus of this effort is requiring post-approval submittal of information within a specified timeframe or after a triggering event (e.g., end of operations reports for plans, construction reports for pipelines, and removal reports for structure removals).

2.2.3. Issues

Issues are defined by CEQ to represent those principal "effects" that an EIS should evaluate in-depth. Scoping identifies specific environmental resources and/or activities rather than "causes" as significant issues (CEQ Guidance on Scoping, April 30, 1981). The analysis in the EIS can then show the degree of change from the present conditions for each issue to the actions related to a proposed action.

Selection of environmental and socioeconomic issues to be analyzed was based on the following criteria:

- issue is identified in CEQ regulations as subject to evaluation;
- the relevant resource/activity was identified through agency expertise, through the scoping process, or from comments on past EIS's;
- the resource/activity may be vulnerable to one or more of the impact-producing factors associated with the OCS Program; a reasonable probability of an interaction between the resource/activity and impact-producing factor should exist; or
- information that indicates a need to evaluate the potential impacts to a resource/activity has become available.

2.2.3.1. Issues to be Analyzed

The following issues relate to potential impact-producing factors and the resources and activities that could be affected by OCS exploration, development, production, and transportation activities.

Accidental Events: Concerns were raised related to the potential impact of oil spills, including the DWH event, on the marine and coastal environments specifically regarding the potential effects of oil spills on tourism, emergency response capabilities, spill prevention, effect of winds and currents on the transport of oil spills, accidental discharges from both deepwater blowouts and pipeline ruptures, and oil spills resulting from past and future hurricanes. Other concerns raised over the years of scoping were the fate and behavior of oil spills, availability and adequacy of oil-spill containment and cleanup technologies, oil-spill cleanup strategies, impacts of various oil-spill cleanup methods, effects of weathering on oil spills, toxicological effects of fresh and weathered oil, air pollution associated with spilled oil, and short-term and long-term impacts of oil on wetlands.

Drilling Fluids and Cuttings: Specific concerns related to drilling fluids include mercury, synthetic-based drilling fluids (SBF) and large volumes of industrial chemicals necessary for deepwater drilling operations, and potential for persistence of drilling muds and cuttings. Other concerns raised over the years of scoping were potential smothering of benthic communities by offshore disposal of drilling fluids and cuttings, the use and disposal of drilling fluids include potential spills of oil-based drilling fluids (OBF), onshore disposal of OBF, the fate and effects of SBF's in the marine environment, and the potential toxic effects or bioaccumulation of trace metals in drilling fluids discharged into the marine environment.

Visual and Aesthetic Interference: Lighting was raised as a specific concern. Concerns raised over the years of scoping were the potential effects of the presence of drilling rigs and platforms, service vessels, helicopters, trash and debris, and flaring on visual aesthetics.

Air Emissions: The potential effects of emissions of combustion gases from platforms, drill rigs, service vessels, and helicopters have been raised as an issue over the years of scoping. Also under consideration are the flaring of produced gases during extended well testing and the potential impacts of transport of production with associated H_2S.

Water Quality Degradation: Issues related to water quality degradation raised over the years of scoping most often were associated with operational discharges of drilling muds and cuttings, produced waters, and domestic wastes. Water quality issues also included concerns related to impacts from sediment disturbance, petroleum spills and blowouts, and discharges from service vessels.

Other Wastes: Other concerns raised over the years of scoping include storage and disposal of trash and debris, and trash and debris on recreational beaches.

Structure and Pipeline Emplacement: Some of the issues raised over the years of scoping related to structure and pipeline emplacement are bottom area disturbances from bottom-founded structures or anchoring, sediment displacement related to pipeline burial, space-use conflicts, and the vulnerability of offshore pipelines to damage that could result in hydrocarbon spills or H_2S leaks.

Platform Removals: Concerns raised over the years of scoping about the abandonment of operations include how a platform is removed, potential impacts of explosive removals on marine organisms, remaining operational debris snagging fishing nets, and site clearance procedures.

OCS-Related Support Services, Activities, and Infrastructure: Specific issues were damage to coastal infrastructure by past hurricane activity and the vulnerability of coastal infrastructure to damage from future hurricanes. Concerns raised over the years of scoping include activities related to the shore-base support of the Development and Production Plan include vessel and helicopter traffic and emissions, construction or expansion of navigation channels or onshore infrastructure, maintenance and use of navigation channels and ports, and deepening of ports.

Sociocultural and Socioeconomic: Many concerns have focused on the potential impacts to coastal communities including demands on public services and tourism. Issues raised from years of scoping include impacts on employment, population fluctuations, effects on land use impacts to low-income or minority populations, and cultural impacts.

OCS Oil and Gas Infrastructure: Specific issues were damage to offshore infrastructure by tropical storms and the vulnerability of offshore infrastructure to damage from future storms.

Other Issues: Many other issues have been identified. Several of these issues are subsets or variations of the issues listed above. All are taken under advisement and are considered in the analyses, if appropriate. Additional issues raised during scoping are new and unusual technologies, noise from platforms, vessels, helicopters, and seismic surveys; turbidity as a result of seafloor disturbance or discharges; mechanical damage to biota and habitats; and multiple-use conflicts.

Resource Topics Analyzed in the EIS: The analyses in **Chapters 4.1-4.5** address the issues and concerns identified above under the following resource topics:

- Air Quality
- Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice
- Archaeological Resources (Historic and Prehistoric)
- Coastal Barrier Beaches and Associated Dunes
- Coastal and Marine Birds
- Commercial Fishing
- Deepwater Benthic Communities (Chemosynthetic and Nonchemosynthetic)
- Diamondback Terrapins
- Fish Resources and Essential Fish Habitat
- Gulf Sturgeon
- Human Resources and Land Use (Land Use and Infrastructure, Demographics, Economic Factors, and Environmental Justice)
- Live Bottoms (Pinnacle Trend and Low Relief)
- Marine Mammals
- Recreational Fishing
- Recreational Resources
- *Sargassum*
- Sea Turtles
- Seagrass Communities
- Soft-Bottom Benthic Communities
- Topographic Features
- Water Quality (Coastal and Offshore)
- Wetlands

2.2.3.2. Issues Considered but Not Analyzed

As previously noted, the CEQ regulations for implementing NEPA instruct agencies to adopt an early process (termed "scoping") for determining the scope of issues to be addressed and for identifying significant issues related to a proposed action. As part of this scoping process, agencies shall identify and eliminate from detailed study the issues that are not significant to the proposed action or have been covered by prior environmental review.

Through our scoping efforts, numerous issues and topics were identified for consideration in this Multisale EIS for the proposed 2012-2017 WPA and CPA lease sales. After careful evaluation and study, the following categories were considered not to be significant issues related to a proposed action or have been covered by prior environmental review.

Program and Policy Issues

Comments and concerns that relate to program and policy are issues under the direction of the Department of the Interior and/or BOEM's guiding regulations, statutes, and laws. The comments and concerns related to program and policy issues are not considered to be specifically related to the proposed action. Such comments are forwarded to the appropriate program offices for their consideration. Programmatic issues including expansion of the sale area, administrative boundaries, and royalty relief have been considered in the preparation of the EIS for the 5-Year Program.

Revenue Sharing

A number of comments were received on previous EIS's from State and local governments, interest groups, and the general public stating that locally affected communities should receive an increased share of revenues generated by the OCS oil and gas leasing program. This increased revenue would act as mitigation of OCS-related impacts to coastal communities including impacts to Louisiana Highway 1 (LA Hwy 1) and Lafourche Parish, Louisiana, from OCS-related activity at Port Fourchon. Comments and concerns that relate to the use and distribution of revenues are issues under the direction of the U.S. Congress or the Department of the Interior, and their guiding regulations, statutes, and laws.

On October 1, 2010, the revenue collection function of BOEMRE became the independent Office of Natural Resource Revenue (ONRR). The ONRR distributes revenues collected from Federal mineral leases to special-purpose funds administered by Federal agencies; to States; and to the General Fund of the U.S. Department of the Treasury. Legislation and regulations provide formulas for the disbursement of these revenues. With the enactment of GOMESA, the Gulf producing States (i.e., Texas, Louisiana, Mississippi, and Alabama) and their coastal political subdivisions (CPS's) were granted an increased share of offshore oil and gas revenue. Beginning in FY 2007, and thereafter, Gulf producing States and their CPS's received 37.5 percent of the qualified OCS revenue from new leases issued in the 181 Area in the EPA and the 181 South Area. Beginning in FY 2016, and thereafter, Gulf producing States and their

CPS's will receive 37.5 percent and the Land and Water Conservation Fund will receive 12.5 percent of qualified OCS revenue from new leases in the existing areas available for leasing, subject to a $500 million cap. The remaining 50 percent of qualified OCS revenues and revenues exceeding the $500 million cap will be distributed to the U.S. Treasury.

The socioeconomic benefits and impacts to local communities are analyzed in **Chapters 4.1.1.20 and 4.2.1.23**.

2.3. PROPOSED WESTERN PLANNING AREA LEASE SALES 229, 233, 238, 246, AND 248

2.3.1. Alternative A—The Proposed Action (Preferred Alternative)

2.3.1.1. Description

Alternative A would offer for lease all unleased blocks within the WPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(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 nmi north of the continental shelf boundary between the U.S. and Mexico.

The WPA sale area encompasses about 28.6 million ac. Approximately 21.2 million ac of the WPA sale area is currently unleased. The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.116-0.200 BBO and 0.538-0.938 Tcf of gas.

The analyses of impacts summarized below and described in detail in **Chapter 4.1** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapter 3**.

Alternative A has been identified as BOEM's preferred alternative; however, this does not mean that another alternative may not be selected in the Record of Decision.

2.3.1.2. Summary of Impacts

Air Quality (Chapter 4.1.1.1)

Emissions of pollutants into the atmosphere from the routine activities associated with a WPA 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. Emissions from proposed-action activities are expected to be well within the NAAQS. As indicated in the GMAQS and other modeling studies, a WPA 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 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. Regulations, monitoring, mitigation, and developing emissions-related technologies would ensure these levels stay within the NAAQS.

Accidental events associated with a WPA proposed action that could impact air quality include spills of oil, natural gas, condensate, and refined hydrocarbons; H_2S release; fire; and 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. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. 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.

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 a rare catastrophic event.

Water Quality (Chapter 4.1.1.2)

Coastal Waters (Chapter 4.1.1.2.1)

The primary impacts to water quality in coastal waters are point-source and storm-water discharges from support facilities, vessel discharges, and nonpoint-source runoff. The impacts to coastal water quality from routine activities associated with a WPA proposed action should be minimal because of the distance to shore of most routine activities, USEPA regulations that restrict discharges, and the few, if any, new pipeline landfalls or onshore facilities that would be constructed.

Accidental events associated with a WPA 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, spills of chemicals or drilling fluids, loss of well control, pipeline failures, collisions, or other malfunctions that would 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 will 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 the spill is in and the proximity of the spill to shore. 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. Spills from collisions are not expected to be significant because collisions occur infrequently.

Offshore Waters (Chapter 4.1.1.2.2)

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. Impacts to offshore waters from routine activities associated with a WPA proposed action should be minimal.

Accidental events associated with a WPA 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. 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 (**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 degradation processes will also decrease the amount of spilled oil over time. 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.

Coastal Barrier Beaches and Associated Dunes (Chapter 4.1.1.3)

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 WPA proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 pipeline landfalls projected in support of a WPA proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods and regulations. New gas processing plants would not be expected to be constructed on barrier beaches. A WPA proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and localized impacts on adjacent barrier beaches downdrift 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. 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. Because these impacts occur whether a WPA proposed action is implemented or not, a proposed action would account for a small percentage of these impacts.

In conclusion, a WPA 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. A WPA proposed action may extend the life and presence of facilities in eroding areas through modifications to channel training structures (jetties) and the utilization of beach restoration and nourishment techniques combined with dune restoration. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas. It is also highly unlikely that oil from the DWH event would be introduced by vessel traffic or channel maintenance due to the distance of the DWH event from the Texas coast and decontamination procedures in place for boats that were inside of the containment booms. In addition, if encountered, the remnant oil is expected to be nontoxic due to natural weathering, microbial breakdown and post-spill dispersant treatment.

Because of the proximity of inshore spills to barrier islands and beaches, these inshore spills pose the greatest threat because of its concentration and lack of weathering by the time it hits the shore and because dispersants are not an effective means of spill response. 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 less 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. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Although the most current information did reveal that some of the barrier islands had experienced storm-induced reductions in beach shoreline elevations and erosion, the significance of this loss of protection is small in comparison with other continuing natural forces such as subsidence, sea-level rise, and the continued reduction in sediment supply, which aid in the deterioration of these islands. Therefore, the currently available information suggests that impacts on barrier islands and beaches from accidental impacts associated with a WPA proposed action would be minimal. However, the long-term effects of the berm construction on Chandeleur Island cannot be evaluated at this time because of 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 WPA proposed action. A WPA proposed action would not pose a significant increase in risk to barrier island or beach resources.

Wetlands (Chapter 4.1.1.4)

A WPA proposed action is projected to contribute to the construction of 0-1 new onshore pipelines. Modern pipelaying techniques and mitigations would be used for such a project. These modern pipelaying techniques use selective placement and directional drilling to avoid wetlands and to reduce the reliance on trenching and for required restoration; thus, the projected impact to wetlands from pipeline emplacement is expected to be negligible. Because of permit requirements, modern techniques, and mitigation, activities associated with a WPA proposed action are expected to cause negligible to low impacts to wetlands. Secondary impacts to wetlands caused by existing pipeline and vessel traffic corridors will continue to cause landloss. Any potential impacts from a WPA proposed action would be reduced through the continued use of armored channels and modern erosion techniques.

Offshore oil spills resulting from a WPA proposed action are not expected to extensively damage any wetlands along the Gulf Coast. As noted above, wetland impacts from offshore spills would be minimized due to the distance of wells and production facilities to the coastal wetlands. In addition, the wetlands are provided protection by the barrier islands, peninsular sand spits, and currents. These factors, combined with the potential for highly weathered or treated oil reaching the shoreline, greatly minimize or eliminate the impacts of offshore spills. However, if an inland oil spill related to a WPA proposed action occurs, some impact to wetland habitat would be expected. The effects from a spill have the highest probability of occurring in Galveston County and Matagorda County, Texas. These are the primary areas where oil produced in the WPA is transported and distributed, and they are west of Plaquemines and St. Bernard Parishes, Louisiana, where oil produced in the CPA is handled. Although the probability of occurrence is low, the greatest threat of an oil spill to wetland habitat is from an inland spill as a result of a vessel accident or pipeline rupture. Wetlands in the northern Gulf of Mexico are either in moderate- to high-energy environments. Sediment transport and tidal stirring should reduce the chances of oil persisting in the event these areas are oiled. While a resulting slick may cause minor impacts to wetland habitat, the equipment and personnel used to clean up the spill can generate the greatest impacts to the area. Associated foot traffic can 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. Overall, impacts to wetland habitats from an oil spill associated with activities related to a WPA proposed action would be expected to be low and temporary.

Seagrass Communities (Chapter 4.1.1.5)

Routine OCS activities in the WPA that may impact seagrasses are not predicted 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 undesirable effects on submerged vegetation beds from dredging activities. These Federal and State permit requirements should ensure pipeline routes avoid high-salinity beds and should maintain water clarity and quality. Local programs decrease the occurrence of prop scarring in grass beds, and generally, channels used by OCS vessels are away from exposed submerged vegetation beds. Because of these requirements, implemented programs, along with the beneficial effects of natural flushing (e.g., from winds and currents), any potential effects from routine activities on seagrasses and SAV's in the WPA are expected to be short term, localized, and not significantly adverse.

Although the size would be small and the duration is quick, 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 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 will decrease detrimental effects to submerged vegetation from a WPA proposed action.

As noted in the **Chapter 4.1.1.5**, there remains uncertainty regarding the impacts of the DWH event on submerged vegetation. At least for submerged vegetation in Louisiana, 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 OCS activities of a WPA proposed action are expected to be minimal because of the distance of most activities from the submerged vegetation beds, because the 0-1 pipeline landfall and maintenance dredging are heavily regulated and permitted, because mitigations (such as turbidity curtains and siting away from beds) may be required, and because the likelihood of an accidental event of size, location, and duration reaching submerged vegetation spills remains small.

Topographic Features (Chapter 4.1.1.6)

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 WPA 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 WPA could be adversely impacted by oil and gas activities resulting from a WPA 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 WPA topographic features.

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 and not followed up by mitigating measures. 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 of 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.

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. Operational 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 operational effluents 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 WPA proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features.

The proposed Topographic Features Stipulation 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 sediment particles would also be at low concentrations by the time the topographic features were reached, also likely resulting in primarily 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.

The topographic features and associated coral reef biota of the WPA could be damaged by oil and gas activities resulting from a WPA 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 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 WPA proposed action are discussed in **Chapter 4.1.1.6.2**.

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. In most cases, recovery from disturbances would take 10 years or more. Dispersants should not be applied near sensitive areas such as coral communities according to NOAA Policy. Although not specifically regulated by BOEM‘s proposed stipulation, the dispersants’ possible use is physically distanced by buffer zones created by BOEM stipulations. Dispersants could be applied at a spill close to sensitive features if the buffer zone between petroleum-producing activity and a sensitive feature is not enforced through stipulations. Indeed, disturbances, including oil spills and blowouts, would 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. Therefore, in the absence of the proposed Topographic Features Stipulation, a WPA proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features in the event of a spill.

Sargassum **Communities (Chapter 4.1.1.7)**

Sargassum, as pelagic algae, is a widely distributed resource that is found throughout the GOM and northwest Atlantic. Considering its ubiquitous distribution and occurrence in the upper water column near the sea surface, it would be contacted by routine discharges from oil and gas operations. All types of discharges including drilling 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 WPA (115,645 km^2; 44,651 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, concentrations of any toxic components would be reduced; therefore, produced-water impacts on *Sargassum* would be minimum. 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 WPA 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.

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 WPA (115,645 km^2; 44,651 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 WPA 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 cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community unless a catastrophic spill occurs.

Chemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.8)

Chemosynthetic communities are susceptible to physical impacts from anchoring, structure emplacement, pipeline installation, structure removal, and drilling discharges. The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring the avoidance of potential chemosynthetic communities. 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 WPA 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 WPA proposed action would be minimal to none.

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. It requires avoidance of 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.

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). 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 WPA 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. 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 WPA 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 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, will 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.

Nonchemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.9)

Deepwater nonchemosynthetic communities are susceptible to physical impacts from anchoring, structure emplacement, pipeline installation, structure removal, and drilling discharges. The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring the avoidance of potential sensitive benthic communities.

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 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.

Routine activities associated with a WPA proposed action are expected to cause no damage to the ecological function or biological productivity of deepwater live-bottom communities (deep coral reefs) due to the consistent application of BOEM protection policies as described in NTL 2009-G40. Impacts on sensitive deepwater communities from routine activities associated with a WPA proposed action would be minimal to none.

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 WPA 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. 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 will 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, 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 WPA proposed action would 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. 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, will 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.

Soft-Bottom Benthic Communities (Chapter 4.1.1.10)

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 WPA (115,645 km^2; 44,651 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 would be are 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. 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.

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 experience lethal impacts as a result of blowouts, surface, and subsurface oil spills and the associated affects. 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. 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, and impacts would be to an extremely small portion of the overall Gulf of Mexico.

Marine Mammals (Chapter 4.1.1.11)

Some routine activities related to a WPA 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.

Although there will always be some level of incomplete information on the effects from routine activities under a WPA 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 WPA proposed action area as a result of existing leases and related activities. As of November 2011, there are 1,302 active leases in the WPA. Within the WPA, 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.

Accidental events related to a WPA 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. 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. These long-term impacts could have population-level effects.

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." Currently, BOEM, NMFS and FWS are in the process of collecting and awaiting additional information, which is being gathered as part of the NRDA process in order to update the environmental baseline information as needed for this reinitiated Section 7 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 5-Year Program (2012-2017), BOEM and BSEE are developing a coordination and review process with NMFS and FWS for specific activities leading up to or resulting from upcoming proposed lease sales. The purpose of this coordination is to ensure that NMFS and FWS have the opportunity to review post-lease 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.

Sea Turtles (Chapter 4.1.1.12)

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 WPA 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.

Although there will always be some level of incomplete information on the effects from routine activities under a WPA proposed action on sea turtles, 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 WPA proposed action area as a result of existing leases and related activities. (As of November 2011, there are 1,302 active leases in the WPA). Within the WPA, 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 sea turtle 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.

Accidental blowouts, oil spills, and spill-response activities resulting from a WPA proposed action 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 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 a WPA proposed action area, regardless of any alternative selected under this EIS, given that, as of November 2011, there are 1,302 active leases in the WPA, 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.

The BOEM concludes that there 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 event. Relevant 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. 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. In the absence of this information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis, applied using accepted scientific methods and approaches. The BOEM does not, however, believe this incomplete information is essential to make a reasoned choice among alternatives primarily because activities that could result in an accidental spill in the WPA would be ongoing whether or not a WPA proposed action occurred. As of November 2011, there are 1,302 active leases in the WPA that are engaged, or have the potential to be engaged in exploration, drilling and/or production activities that could theoretically result in an accidental spill. Given these existing leases and this ongoing activity, any incomplete information that may lead to reasonably foreseeable, significant adverse impacts to sea turtles is not needed to make a reasoned choice among alternatives, including the No Action alternative.

Diamondback Terrapins (Chapter 4.1.1.13)

Adverse impacts due to routine activities resulting from a WPA 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 WPA 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.

Although there will always be some level of incomplete information on the effects of routine activities on diamondback terrapin under a WPA proposed action, 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 WPA proposed action area as a result of existing leases and related activities. As of November 2011, there are 1,302 active leases in the WPA. Within the WPA, 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. 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.

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 the WPA proposed action area, regardless of any alternative selected under this EIS, given that, as of November 2011, there are 1,302 active leases already in the WPA 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.

The BOEM concludes that there is incomplete or unavailable information that may lead to reasonably foreseeable, significant adverse impacts to diamondback terrapins from accidental events. For example, there is incomplete information on impacts to diamondback terrapin populations from the DWH event or from impacts that could result from a similar catastrophic spill. Relevant data on the status of and impacts to diamondback terrapin populations from the DWH may take years to acquire and analyze, and impacts from the DWH 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 the absence of this information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches. The BOEM does not, however, believe this incomplete information is essential to make a reasoned choice among alternatives primarily because activities that could result in an accidental spill in the WPA would be ongoing whether or not a WPA proposed action occurred. As of November 2011, there are 1,302 active leases in the WPA that are engaged, or have the potential to be engaged, in exploration, drilling, and/or production activities that could theoretically result in an accidental spill. Given these existing leases and this ongoing activity, any incomplete information that may lead to reasonably foreseeable, significant adverse impacts to diamondback terrapins is not needed to make a reasoned choice among alternatives, including the No Action alternative.

Coastal and Marine Birds (Chapter 4.1.1.14)

The majority of the effects resulting from routine activities of the WPA proposed action (**Tables 3-2, 3-4, and 3-5**) 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 4.1.1.12.1**). 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. The addition of 15-23 installed platforms would probably result in the collision death of an additional 750-1,150 birds/year or 30,000-46,000 over the 40-year life of newly installed platforms (**Table 4-7**). This represents an adverse, but not significant, impact to coastal and marine birds. Over the life of the GOM platform archipelago, mortality estimates may be on the order of 7-12 million birds (**Table 4-7**). 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 WPA 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 (WPA) as a result of existing leases and related activities (As of November 2011, there are 1,302 active leases in the WPA). Within the WPA, 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 sea turtle 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 WPA proposed action; 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. However, avoidance measures and conditions are routinely placed on permitted activities to protect habitat (**Table 4-2**).

Overall, impacts to coastal and marine birds associated with accidental events (oil spills regardless of size) in the WPA should be less than in the CPA due to the following factors: fewer platforms; lower oil-spill probabilities; and much lower numbers of predicted oil spills, particularly pipeline spills over the life of a WPA proposed action (**Tables 3-2, 3-4, 3-5, 3-12, and 3-19**). 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. Small amounts of oil can affect birds, and mortality from oil spills is often related to numerous symptoms of toxicity. Data from actual spills strongly suggest that impacts to a bird species' food supply are typically delayed after initial impacts from direct oiling. Sublethal, long-term effects of oil on birds have previously been documented, including changes to sexual signaling.

Oil-spill impacts on birds from a WPA 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 WPA proposed action. Impacts of oil-spill cleanup from a WPA proposed action are also expected to be adverse but not significant, but they may be negligible depending on the scope and scale of efforts. Significant impacts to coastal and marine birds could result in the event of a catastrophic spill, depending on the timing, location, and size of the spill. For additional information on a catastrophic spill, see **Appendix B**.

Fish Resources and Essential Fish Habitat (Chapter 4.1.1.15)

The BOEM has examined the analysis for impacts to fish resources and EFH based on the additional information presented above. Because of the mitigations described in the above analysis, a WPA proposed action is expected to result in a minimal decrease in fish resources and/or standing stocks or in EFH. It would require a short time for fish resources to recover from most of the impacts because impacts to the habitat would generally be temporary; fish tend to avoid areas of impact (thus reducing mortality effects) and most fish species are prolific reproducers. Recovery from the loss of wetlands habitat would probably not occur, but it would likely result in conversion of the lost wetland habitats into open water or mudflats, which may qualify as other forms of EFH.

It is expected that any possible coastal and marine environmental degradation from a WPA 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.

Additional hard-substrate habitat provided by structure installation in areas where natural hard bottom is rare would tend to increase fish populations. The removal of these structures would eliminate that habitat, except when decommissioned platforms are used as artificial reef material. This practice is expected to increase over time.

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 WPA 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. Fish and shellfish eggs and larvae would be unable to avoid spills, and early development stages may be at greater risk. Fish populations may be impacted by an oil spill but they will be primarily affected if the oil reaches the shelf and estuarine areas because these are the most productive areas and because 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. The extent of the impacts of the oil would depend on the properties of the oil and the time of year of the event. Also, much of the coastal northern Gulf of Mexico is a moderate- to high-energy environment; therefore, sediment transport and tidal stirring should reduce the chances for oil persisting in these habitats if they are oiled.

The effect of WPA proposed-action-related oil spills on fish resources is expected to cause a minimal decrease in standing stocks of any population because the most common 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 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.

The BOEM has determined that it cannot obtain this information, regardless of cost, within the timeframe of 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 event on fish resources and essential fish habitat, BOEM has determined that it is impossible to obtain this information, regardless of cost, within the timeframe of this NEPA analysis, and it may be years before the information is available. This information is being developed through the NRDA process, data is still incoming and has 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 WPA 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.

Commercial Fishing (Chapter 4.1.1.16)

Some of the impact-causing actions described above are mitigated by BOEM through the Topographic Feature Stipulations applied to each lease sale that establishes a No Activity Zone around important topographic features, such as the Flower Garden Banks. Also, NTL 2009-39 advises operators to avoid hard-bottom habitats that support fish populations, and USEPA's discharge permit system mitigates potential impacts from produced water.

Much of coastal wetland loss that supports the estuaries upon which fish stocks are dependent is 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 is in a limited area by the produced-water discharge and the overboard discharge of drilling muds. Pipeline trenching, maintenance dredging, and canal widening in inshore areas causes only temporary suspension of sediments. Negative impacts from most of these routine operations would require a short time for fish resources to recover. Recovery from the loss of wetlands habitat would probably not occur.

Space-use conflicts will continue in the offshore area, although the area off limits to fishing (especially longlining) is small. Some gear loss will continue to occur as will down time from seismic surveys. The Fishermen's Compensation Fund compensates U.S. commercial fishermen and other eligible citizens and entities for property and economic loss caused by obstructions related to oil and gas development activities on the OCS. The NMFS administers and processes Fishermen's Contingency Fund claims, and BOEM coordinates communications with OCS leaseholders and maintains the database for reported obstructions. The level of impact of a WPA proposed action on the commercial fisheries in the WPA is expected to be small.

Additional hard-substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase 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.

Negative impacts from most of these routine operations would require a short time for fish resources to recover. Recovery from the loss of wetlands habitat would probably not occur.

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 WPA proposed action is expected to result in a minimal decrease in fish resources.

The BOEM has examined the available data for impacts of a WPA proposed action to commercial fisheries in the WPA. Accidental events that could impact commercial fisheries 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 fisheries resources in the immediate area of the blowout.

Oil spills on the OCS due to a WPA proposed action are highly unlikely. If oil spills due to a WPA 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 avoid a spill. This behavioral mechanism allows them to move away from the source of the hydrocarbons, therefore minimizing the likelihood of fish kills.

The most damaging oil spills to commercial fisheries populations would be those reaching the productive shelf or estuaries. Negative impacts would be maximum on those populations that are short lived and harvested annually, such as crabs and shrimp, or those populations that are sessile, such as oysters. Spills of this magnitude from the EEZ have, however, a very low probability of occurrence historically.

Most closures from oil spills are small and short lived. Fishermen are generally able to avoid the area, causing only localized economic impacts. Large-scale closures are rare but can temporarily inflict a negative impact on commercial fishermen and the sale of local fish products. Closures may also relieve fishing pressure and allow fisheries populations to increase the following year.

In summary, the impacts of a WPA proposed action from accidental events (i.e., a well blowout or an oil spill) are anticipated to be minimal 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.

Recreational Fishing (Chapter 4.1.1.17)

There may be minor space-use conflicts with recreational fishermen during the initial phases of a WPA proposed action. A proposed action may also lead to low-level environmental degradation of fish habitat, which would negatively impact recreational fishing activity. However, these minor negative effects would likely be outweighed by the beneficial role that oil rigs serve as artificial reefs for fish populations. The degree to which oil platforms will become a part of a particular State's Rigs-to-Reefs program will be an important determinant of the degree to which a WPA proposed action will impact recreational fishing activity in the long term.

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 noticeable 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.

Recreational Resources (Chapter 4.1.1.18)

Routine OCS actions in the WPA 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 WPA proposed action has the potential to directly and indirectly impact recreational resources along the coast of Texas. However, the small scale of a WPA 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.

Spills most likely to result from a WPA proposed action will 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 will 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 significant.

Archaeological Resources (Chapter 4.1.1.19)

Historic (Chapter 4.1.1.19.1)

The greatest potential impact to an archaeological resource as a result of a WPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, and dredging or pipeline project) 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 250.194(c) and 30 CFR 250.1010(c), lessees are required to notify BOEM immediately of the discovery of any potential archaeological resources.

Offshore oil and gas activities resulting from a WPA 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 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 WPA 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.

Accidental events producing oil spills may threaten archaeological resources along the Gulf Coast. Should a spill contact a historic archaeological site (including submerged sites), 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. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. It is expected that any spill cleanup operations would be considered a Federal action for the purposes of Section 106 of the National Historic Preservation Act (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. Detailed risk analyses of offshore oil spills ranging from ≥1,000 bbl, ≤1,000 bbl, and coastal spills associated with a WPA proposed action are provided in **Chapters 3.2.1.5**, **3.2.1.6**, **and 3.2.1.7** 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 areas.

The potential for spills is low, the effects would generally be localized, and the cleanup efforts would be regulated. A WPA 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.

Prehistoric (Chapter 4.1.1.19.2)

The greatest potential impact to an archaeological resource as a result of a WPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, and dredging or pipeline project) 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 surveys, 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 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/or unique archaeological information.

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 WPA proposed action are provided in **Chapters 3.2.1.5**, **3.2.1.6, and 3.2.1.7**, 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 WPA proposed action. A WPA proposed action, therefore, is not expected to result in impacts to prehistoric archaeological sites.

Human Resources and Land Use (Chapter 4.1.1.20)

Land Use and Coastal Infrastructure (Chapter 4.1.1.20.1)

The impacts of routine events associated with a WPA proposed action are uncertain due to the post-DWH 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 WPA proposed action. However, based on the most current information available, there is only a very slim chance that either would result from a WPA 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. 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 WPA proposed action. If drilling activity recovers post-DWH event and increases, there may be new increased demand for a waste disposal services as a result of a WPA proposed action. Because of the current near zero estimates for a pipeline landfall and gas processing facility construction, the routine activities associated with a WPA 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 will 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 WPA proposed action.

Accidental events associated with a WPA proposed action occur at different levels of severity, based in part on the location and size of the 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, high-impact 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. The indirect effects on infrastructure use are still rippling through the industry, but this should resolve as issues with the moratorium, 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, high-impact catastrophic event. For the reasons set forth in the analysis above, the kinds of accidental events that are likely to result from a WPA 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.

Demographics (Chapter 4.1.1.20.2)

A WPA proposed action is projected to minimally affect the demography of the analysis area. Population impacts from a WPA proposed action are projected to be minimal (<1% of the total population) for any economic impact area (EIA) in the Gulf of Mexico region. The baseline population patterns and distributions, as projected and described in **Chapter 4.1.1.20.2.1**, are expected to remain unchanged as a result of a WPA 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.

Accidental events associated with a WPA 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.

Economic Factors (Chapter 4.1.1.20.3)

Should a WPA 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 WPA proposed action is expected to occur in Texas (primarily in the EIA TX-3) and in the coastal areas of Louisiana. A WPA proposed action, irrespective of whether one analyzes the high-case or low-case production scenario, would not cause employment effects >0.1 percent in any EIA along the Gulf Coast.

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.

Environmental Justice (Chapter 4.1.1.20.4)

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a WPA proposed action are expected to be widely distributed and to have little impact. In general, who will be hired and where new infrastructure might be located is impossible to predict, but, in any case, it will be very limited. Impacts related to a WPA proposed action are expected to be economic and to have a limited but positive effect on low-income and minority populations because it will maintain 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 4.1.1.20.4.1**), a WPA proposed action is not expected to have a disproportionate effect on these populations within the WPA.

A WPA proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a WPA 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. Many of the long-term impacts of the DWH event to low-income and minority communities are 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. 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 affects. To date, there have been no longitudinal epidemiological 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.

The DWH event was a low-probability, high-impact 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 WPA 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.

Species Considered due to U.S. Fish and Wildlife Concerns (Chapter 4.1.1.21)

Because of the mitigations likely to be implemented in place, routine activities (e.g., operational discharges, noise, and marine debris) related to a WPA proposed action are not expected to have long-term adverse effects on the size and productivity of any 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 WPA 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 WPA proposed action would not be likely to result in a significant incremental impact on the above mammal and plant species within the WPA; in comparison, non-OCS-related activities, such as habitat loss and competition, have historically proved to be of greater threat to the species.

In conclusion, a WPA proposed action would have no effect on the species. The conclusions for the following species can be found in their respective chapters of this EIS: West Indian manatee (**Chapter 4.1.1.11**); green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles (**Chapter 4.1.1.12**); and Attwater's greater prairie-chicken, northern aplomado falcon, piping plover, whooping crane, and mountain plover (**Chapter 4.1.1.14**).

2.3.1.3. Mitigating Measures

2.3.1.3.1. Topographic Features Stipulation

The topographic features located in the WPA provide habitat for coral-reef-community organisms (**Chapters 4.1.1.6**). Oil and gas activities resulting from a proposed action could have a severe, even lethal, impact on or near these communities if the Topographic Features Stipulation is not adopted and such activities were not otherwise mitigated. The DOI has recognized this problem for some years, and since 1973 stipulations have been made a part of leases on or near these biotic communities; impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation would not prevent the recovery of oil and gas resources but would serve to protect valuable and sensitive biological resources.

The Topographic Features Stipulation was formulated based on consultation with various Federal agencies and comments solicited from the States, industry, environmental organizations, and academic representatives. The stipulation is based on years of scientific information collected since the inception of the stipulation. This information includes various Bureau of Land Management/MMS (BOEM)-funded studies of topographic highs in the GOM; numerous stipulation-imposed, industry-funded monitoring reports; and the National Research Council (NRC) report entitled *Drilling Discharges in the Marine Environment* (1983). The location of the blocks affected by the Topographic Features Stipulation is shown on **Figure 2-1**.

The requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer confines the effluent to a level deeper than that of the living components of a high-relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high-relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NRC, 1983).

(b) The biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 meters (m) of the discharge (NRC, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef-building activity (Rezak and Bright, 1981; Rezak et al., 1983 and 1985).

The stipulation establishes No Activity Zones at the topographic features. A zone is defined by the 85-m bathymetric contour (isobath) because, generally, the biota shallower than 85 m (279 ft) are more typical of the Caribbean reef biota, while the biota deeper than 85 m (279 ft) are similar to soft-bottom organisms found throughout the Gulf. Where a bank is in water depths less than 85 m (279 ft), the deepest "closing" isobath defines the No Activity Zone for that topographic feature. Within the No Activity Zones, no operations, anchoring, or structures are allowed. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted.

The stipulation requires that all effluents within 1,000 m (3,281 ft) of banks containing an antipatharian-transitional zone be shunted to within 10 m (33 ft) of the seafloor. Banks containing the more sensitive and productive algal-sponge zone require a shunt zone extending 1 nmi (1.2 mi; 1.9 km) and an additional 3-nmi (35 mi; 5.6 km) shunt zone for development only.

Exceptions to the general stipulation are made for the Flower Garden Banks and the low-relief banks. Because the East and West features of the Flower Garden Banks have received National Marine Sanctuary status, they are protected to a greater degree than the other banks. The added provisions at the Flower Garden Banks require that (a) the No Activity Zone be based on the 100-m isobath instead of the 85-m isobath and be defined by the "1/4 1/4 1/4" system (a method of defining a specific portion of a block) rather than the actual isobath and (b) there be a 4-Mile Zone instead of a 1-Mile Zone in which shunting is required. Although Stetson Bank (a high-relief feature) was made part of the Flower Garden Banks National Marine Sanctuary in 1996, it has not as yet received added protection that would differ from current stipulation requirements.

Low-relief banks have only a No Activity Zone. A shunting requirement would be counterproductive because it would put the potentially toxic drilling muds in the same water depth range as the features associated biota that are being protected. Also, the turbidity potentially caused by the release of drilling effluents in the upper part of the water column would not affect the biota on low-relief features as they appear to be adapted to high turbidity. Claypile Bank, which is a low-relief bank that exhibits the *Millepora*-sponge community, has been given the higher priority protection of a 1,000-Meter Zone where monitoring is required.

The stipulation reads as follows:

Topographic Features Stipulation

(a) No activity including structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the leases on banks as listed above.

(b) Operations within "1,000-Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

(c) Operations within "1-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom. (Where there is a "1-Mile Zone" designated, the "1,000-Meter Zone" in paragraph (b) is not designated.) This restriction on operations also applies to areas surrounding the Flower Garden Banks National Marine Sanctuary, namely the "4-Mile Zone" surrounding the East Flower Garden Bank and the West Flower Garden Bank.

(d) Operations within "3-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

The banks and corresponding blocks to which this stipulation may be applied in the WPA are as follows:

Shelf Edge Banks		Low-Relief Banks[2]		South Texas Banks[4]	
Bank Name	Isobath (m)	Bank Name	Isobath (m)	Bank Name	Isobath (m)
West Flower Garden Bank (defined by ¼ ¼ ¼ system)	100	Mysterious Bank	74, 76, 78, 80, 84	Dream Bank	78, 82
		Coffee Lump	Various	Southern Bank	80
East Flower Garden Bank (defined by ¼ ¼ ¼ system)	100	Blackfish Ridge	70	Hospital Bank	70
		Big Dunn Bar	65	North Hospital Bank	68
MacNeil Bank	82	Small Dunn Bar	65	Aransas Bank	70
29 Fathom Bank	64	32 Fathom Bank	52	South Baker Bank	70
Rankin Bank	85	Claypile Bank[3]	50	Baker Bank	70
Bright Bank[1]	85				
Stetson Bank	52				
Appelbaum Bank	85				

[1]CPA bank with a portion of its “3-Mile Zone” in the WPA.
[2]Low-Relief Banks—only paragraph (a) of the stipulation applies.
[3]Claypile Bank—only paragraphs (a) and (b) of the stipulation apply. In paragraph (b), monitoring of the effluent to determine the effect on the biota of Claypile Bank shall be required rather than shunting.
[4]South Texas Banks—only paragraphs (a) and (b) of the stipulation apply.

Effectiveness of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from adverse effects due to routine oil and gas activities. Such effects include physical damage from anchoring and rig emplacement and potential toxic and smothering effects from muds and cuttings discharges. The Topographic Features Stipulation has been used on leases since 1973 and has effectively prevented damage to the biota of these banks from routine oil and gas activities such as anchoring. Monitoring studies have demonstrated that the shunting requirements of the stipulation are effective in preventing the muds and cuttings from impacting the biota of the banks. The stipulation, if adopted for a proposed action, will continue to protect the biota of the banks, specifically as discussed below.

The stipulation provides different levels of protection for banks in different categories as defined by Rezak and Bright (1981). The categories and their definitions are as follows:

Category A: zone of major reef-building activity; maximum environmental protection recommended;

Category B: zone of minor reef-building activity; environmental protection recommended;

Category C: zone of negligible reef-building activity, but crustose algae present; environmental protection recommended; and

Category D: zone of no reef-building or crustose algae; additional protection not necessary.

Mechanical damage resulting from oil and gas operations is probably the single most serious impact to benthic habitat. Complying with the No Activity Zone designation of the Topographic Features Stipulation should completely eliminate this threat to the sensitive biota of topographic features from activities resulting from a proposed action.

Several other impact-producing factors may threaten communities associated with topographic features. Vessel anchoring and structure emplacement result in physical disturbance of benthic habitat and are the most likely activities to cause permanent or long-lasting impacts to sensitive offshore habitats. Recovery from damage caused by such activities may take 10 or more years (depending on the maturity of the impacted community). Operational discharges (drilling muds and cuttings, produced waters) may impact the biota of the banks because of turbidity and sedimentation, resulting in death to benthic organisms in large areas. Recovery from such damage may take 10 or more years (depending on the maturity of the impacted community). Blowouts may cause similar damage to benthic biota by re-suspending sediments, causing turbidity and sedimentation, which could ultimately have a lethal impact on benthic organisms. Recovery from such damage may take up to 10 years (depending on the maturity of the impacted community). Oil spills will cause damage to benthic organisms if the oil contacts the organisms; such contact is unlikely except from spills from blowouts. There have been very few blowouts in the Gulf. Structure removal using explosives can result in water turbidity, redeposition of sediments, and explosive shock-wave impacts. Recovery from such damage could take more than 10 years (depending on the maturity of the impacted community). The above activities, especially bottom-disturbing activities, have the greatest potential to severely impact the biota of topographic features. Those activities having the greatest impacts are also those most likely to occur. A WPA proposed action, without benefit of the Topographic Features Stipulation or comparable mitigation, is expected to have a severe impact on the sensitive offshore habitats of the topographic features.

The biota of low-relief banks and the turbidity of the water are such that protective measures to restrain drilling discharges are not warranted for these features.

The stipulation provides an added measure of protection for Claypile Bank, requiring both No Activity and 1,000-Meter Zones. Claypile Bank is the only low-relief bank that is known to contain the *Millepora*-sponge community. This assemblage is categorized by Rezak and Bright (1981) as a Category B community (minor reef-building activity) worthy of increased protection; therefore, monitoring will be required within the 1,000-Meter Zone. Any impacts from drilling will thereby be documented so that further protective measures could be taken. Due to the low relief of the bank (5 m; 16 ft), shunting would be counterproductive.

The stipulation requires that all drill cuttings and drilling fluids within 1,000 m (3,281 ft) of high-relief topographic features categorized by Rezak and Bright (1981) as Category C banks (negligible reef-building activity) be shunted into the nepheloid layer; the potentially harmful materials in drilling muds would be trapped in the bottom boundary layer and would not move up the banks where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m (3,281 ft) from the bank is not expected to adversely impact the biota.

The stipulation protects the remaining banks (Category A and B banks—major and minor reef building) with even greater restrictions. Appelbaum Bank is categorized as Category C; however, it contains the algal-sponge community, which is indicative of Category A banks. Therefore, it carries a Category A bank stipulation. Surface discharge will not be allowed within 1 nmi (1.2 mi; 1.9 km) of these more sensitive banks. Surface discharges outside of 1 nmi (1.2 mi; 1.9 km) are not expected to adversely impact the biota of the banks. However, when multiple wells are drilled from a single platform (surface location), which is typical during development operations, extremely small amounts of muds discharged more than 1 nmi (1.2 mi; 1.9 km) from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged from numerous wells outside of 1 nmi (1.2 mi; 1.9 km), the stipulation imposes a 3-Mile Zone within which shunting of development effluent is required. The stipulation results in increased protection to the East and West features of the Flower Garden Banks. Shunting would be required within a 4-Mile Zone.

The surface discharge of drilling muds and cuttings resulting from exploratory wells within the 3-Mile Zone is not expected to reach or affect the biological resources located within the No Activity Zone for three main reasons: (1) the biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m (3,281 ft) of the discharge (NRC, 1983); (2) exploration usually requires the drilling of one to four wells per site as opposed to more than five in the case of development; and (3) a significantly lower volume of exploration drilling discharges is expected per site since development usually requires the drilling of several additional wells over greater distances to reach potential reservoirs. The requirement to shunt drilling discharges within the 3-Mile Zone during development drilling is in response to the strong recommendation by FWS.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from a proposed action, while allowing the development of nearby oil and gas resources. The stipulation would not protect the banks from adverse effects of an accident such as a large blowout on a nearby oil or gas operation.

2.3.1.3.2. Military Areas Stipulation

The Military Areas Stipulation has been applied to all blocks leased in military areas since 1977 and reduces potential impacts, particularly in regards to safety; but, it does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The stipulation contains a "hold harmless" clause (holding the U.S. Government harmless in case of an accident involving military operations) and requires lessees to coordinate their activities with appropriate local military contacts. **Figure 2-2** shows the military warning areas in the Gulf of Mexico.

Military Areas Stipulation

(a) Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the OCS, to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the OCS, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States Government, its contractors or subcontractors, or any of its officers, agents or employees, being conducted as a part of, or in connection with, the programs and activities of the command headquarters listed at the end of this stipulation.

Notwithstanding any limitation of the lessee's liability in Section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, or to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

(b) Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of its agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters to the degree necessary to prevent damage to, or unacceptable interference with, Department of Defense flight, testing, or operational activities, conducted within individual designated warning areas. Necessary monitoring control, and coordination with the lessee, its agents, employees, invitees, independent contractors or subcontractors, will be effected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, independent contractors or subcontractors and onshore facilities.

(c) Operational

The lessee, when operating or causing to be operated on its behalf, boat, ship, or aircraft traffic into the individual designated warning areas, shall enter into an agreement with the commander of the individual command headquarters listed in the following list, upon utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats, ships, and aircraft operating into the warning areas at all times.

Effectiveness of the Lease Stipulation

The hold harmless section of the military stipulation serves to protect the U.S. Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and its agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and its agents to reduce and curtail the use of radio, CB, or other equipment emitting electromagnetic energy within some areas. This serves to reduce the impact of oil and gas activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of oil and gas activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers that will avoid the areas where oil and gas activities are taking place or to schedule around these activities. Prior notification helps reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

This stipulation reduces potential impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The reduction in potential impacts resulting from this stipulation makes multiple-use conflicts most unlikely. Without the stipulation, some potential conflict is likely. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and oil and gas activities.

2.3.1.3.3. Protected Species Stipulation

The Protected Species Stipulation has been applied to all blocks leased in the GOM since December 2001. This stipulation was developed in consultation with the Department of Commerce, National Oceanic and Atmospheric Administration, NMFS; and the Department of the Interior, FWS in accordance with Section 7 of the Endangered Species Act and is designed to minimize or avoid potential adverse impacts to federally protected species.

Protected Species Stipulation

To reduce the potential taking of federally protected species (e.g., sea turtles, marine mammals, Gulf sturgeon, and other listed species):

(a) The BOEM will condition all permits issued to lessees and their operators to require them to collect and remove flotsam resulting from activities related to exploration, development, and production of this lease.

(b) The BOEM will condition all permits issued to lessees and their operators to require them to post signs in prominent places on all vessels and platforms used as a result of activities related to exploration, development, and production of this lease detailing the reasons (legal and ecological) why release of debris must be eliminated.

(c) The BOEM will require that vessel operators and crews watch for marine mammals and sea turtles, reduce vessel speed to 10 knots or less when assemblages of cetaceans are observed and maintain a distance of 90 m or greater from whales, and a distance of 45 m or greater from small cetaceans and sea turtles.

(d) The BOEM will require that all seismic surveys employ mandatory mitigation measures including the use of a 500-meter “exclusion zone” based upon the appropriate water depth, ramp-up and shut-down procedures, visual monitoring and reporting. Seismic operations must immediately cease when certain marine mammals are detected within the 500-meter exclusion zone. Ramp-up procedures and seismic surveys may be initiated only during daylight unless alternate monitoring methods approved by BOEM are used.

(e) The BOEM will require lessees and operators to instruct offshore personnel to immediately report all sightings and locations of injured or dead protected species (marine mammals and sea turtles) to the appropriate stranding network. If oil and gas industry activity is responsible for the injured or dead animals (e.g. because of a vessel strike), the responsible parties should remain available to assist the stranding network. If the injury or death was caused by a collision with your vessel, you must notify BOEM within 24 hours of the strike.

(f) The BOEM will require oil spill contingency planning to identify important habitats, including designated critical habitat, used by listed species (e.g. sea turtle nesting beaches, piping plover critical habitat), and require the strategic placement of spill cleanup equipment to be used only by personnel trained in less-intrusive cleanup techniques on beach and bay shores.

Lessees and operators will be instructed how to implement these mitigating measures in Notices to Lessees (NTL’s).

Effectiveness of the Lease Stipulation

This stipulation was developed in consultation with NMFS and FWS, and is designed to minimize or avoid potential adverse impacts to federally protected species.

2.3.1.3.4. Law of the Sea Convention Royalty Payment Stipulation

The Law of the Sea Convention Royalty Payment Stipulation applies to blocks or portions of blocks beyond the U.S. Exclusive Economic Zone (generally greater than 200 nmi [230 mi; 370 km] from the U.S. coastline). Leases on these blocks may be subject to special royalty payments under the provisions of the 1982 Law of the Sea Convention (consistent with Article 82), if the U.S. becomes a party to the Convention prior to or during the life of the lease.

Law of the Sea Convention Royalty Payment Stipulation

(1) The Convention requires payments annually by coastal States party to the Convention with respect to all production at a site after the first 5 years of production at that site. Any such payments will be made by the U.S. Government and not the lessee.

(2) For the purpose of this stipulation regarding payments by the lessee to the U.S. Government, a site is defined as an individual lease whether or not the lease is located in a unit.

(3) For the purpose of this stipulation, the first production year begins on the first day of commercial production (excluding test production). Once a production year begins, it shall run for a period of 365 days whether or not the lease produces continuously in commercial quantities. Subsequent production years shall begin on the anniversary date of first production.

(4) If total lease production during the first 5 years following first production exceeds the total royalty suspension volume(s) provided in the lease terms, or through application and approval of relief from royalties, the following provisions of this stipulation will not apply. If, after the first 5 years of production, but prior to termination of this lease, production exceeds the total royalty suspension volume(s) provided in the lease terms or through application and approval of relief from royalties, the following provisions of this stipulation will no longer apply effective the day after the suspension volumes have been produced.

(5) If, in any production year after the first 5 years of lease production, due to lease royalty suspension provisions or through application and approval of relief from royalties, no lease production royalty is due or payable by the lessee to the U.S. Government, then the lessee will be required to pay, as stipulated in paragraph 9 below, Convention-related royalty in the following amount so that the required Convention payments may be made by the U.S. Government, as provided under the Convention:

(a) In the sixth year of production, 1 percent of the value of the sixth year's lease production saved, removed, or sold from the leased area;

(b) After the sixth year of production, the Convention-related royalty payment rate shall increase by 1 percent for each subsequent year until the twelfth year and shall remain at 7 percent thereafter until lease termination.

(6) If the U.S. Government becomes a party to the Convention after the fifth year of production from the lease, and a lessee is required, as provided herein, to pay Convention-related royalty, the amount of the royalty due will be based on the above payment schedule as determined from first production. For example, U.S. Government accession to the Convention in the tenth year of lease production would result in a Convention-related royalty payment of 5 percent of the value of the tenth year's lease production, saved, removed, or sold from the lease. The following year, a payment of 6 percent would be due, and so forth, as stated above, up to a maximum of 7 percent per year.

(7) If, in any production year after the first 5 years of lease production, due to lease royalty suspension provisions or through application and approval of relief from royalties, lease production royalty is paid but is less than the payment provided for by the Convention, then the lessee will be required to pay to the U.S. Government the Convention-related royalty in the amount of the shortfall.

(8) In determining the value of production from the lease if a payment of Convention-related royalty is to be made, the provisions of the lease and applicable regulations shall apply.

(9) The Convention-related royalty payment(s) required under paragraphs 5 through 7 of this stipulation, if any, shall not be paid monthly but shall be due and payable to the Office of Natural Resources Revenue on or before 30 days after the expiration of the relevant production lease year.

(10) The lessee will receive royalty credit in the amount of the Convention-related royalty payment required under paragraphs 5 through 7 of this stipulation, which will apply to royalties due under the lease for which the Convention-related royalty accrued in subsequent periods, as non-Convention related royalty payments become due.

(11) Any lease production for which the lessee pays no royalty other than a Convention-related requirement, due to lease royalty suspension provisions or through application and approval of relief from royalties, will count against the lease's applicable royalty suspension or relief volume.

(12) The lessee will not be allowed to apply or recoup any unused Convention-related credit(s) associated with a lease that has been relinquished or terminated.

2.3.2. Alternative B—The Proposed Action Excluding the Unleased Blocks Near the Biologically Sensitive Topographic Features

2.3.2.1. Description

Alternative B differs from Alternative A by not offering the blocks that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.3.1.3.1** and **Figure 2-1**). All of the assumptions (including the three other potential mitigating measures; Law of the Sea Convention Royalty Payment Stipulation is not a mitigation) and estimates are the same as for Alternative A. A description of Alternative A is presented in **Chapter 2.3.1.1**.

2.3.2.2. Summary of Impacts

The analyses of impacts summarized in **Chapter 2.3.1.2** and described in detail in **Chapter 4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapter 3**.

The difference between the potential impacts described for Alternative A and those under Alternative B is that under Alternative B no oil and gas activity would take place in the blocks subject to the Topographic Features Stipulation (**Figure 2-1**). The number of blocks that would not be offered under Alternative B represents only a small percentage of the total number of blocks to be offered under Alternative A; therefore, it is assumed that the levels of activity for Alternative B would be essentially the same as those projected for a proposed action. As a result, the impacts expected to result from Alternative B would be very similar to those described under the proposed action (**Chapter 4**). Therefore, the regional impact levels for all resources, except for the topographic features, would be similar to those described under the proposed action. This alternative, if adopted, would prevent any oil and gas activity whatsoever in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks from oil and gas activities, which otherwise would be conducted within the blocks.

2.3.3. Alternative C—No Action

2.3.3.1. Description

Alternative C 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 lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed.

2.3.3.2. Summary of Impacts

Canceling a proposed lease sale would eliminate the effects described for Alternative A (**Chapter 4.1**). The incremental contribution of a proposed lease sale to cumulative effects would also be foregone, but effects from other activities, including other OCS lease sales, would remain.

If a 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 WPA would only be reduced by a small percentage, if any. Therefore, the cancellation of a proposed lease sale would not significantly change the environmental impacts of overall OCS activity. However, the cancellation of a lease sale may result in direct economic impacts to the individual companies. Revenues collected by the Federal Government (and thus revenue disbursements to the States) would be adversely affected also.

Other sources of energy may substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant negative environmental impacts of their own.

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

2.4.1. Alternative A—The Proposed Action (Preferred Alternative)

2.4.1.1. Description

Alternative A would offer for lease all unleased blocks within the CPA for oil and gas operations (**Figure 1-1**), with the following exceptions:

(1) blocks that were previously included within the Eastern GOM Planning Area and are within 100 miles of the Florida coast;

(2) blocks east of the Military Mission line (86 degrees, 41 minutes west longitude) under an existing moratorium until 2022, as a result of the Gulf of Mexico Energy Security Act of 2006 (December 20, 2006);

(3) blocks that are beyond the United States 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 CPA sale area encompasses about 63 million ac of the CPA's 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 a proposed CPA lease sale is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas **(Table 3-1**).

The analyses of impacts summarized below and described in detail in **Chapter 4.2** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapter 3**.

Alternative A has been identified as BOEM's preferred alternative; however, this does not mean that another alternative may not be selected in the Record of Decision.

2.4.1.2. Summary of Impacts

Air Quality (Chapter 4.2.1.1)

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. 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. Regulations, monitoring, mitigation, and developing emissions-related technologies would ensure these levels stay within the NAAQS.

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; 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.

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. 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 (**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 a rare catastrophic event.

Water Quality (Chapter 4.2.1.2)

Coastal Waters (Chapter 4.2.1.2.1)

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.

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.

Offshore Waters (Chapter 4.2.1.2.2)

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.

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. 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.

Coastal Barrier Beaches and Associated Dunes (Chapter 4.2.1.3)

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. 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. 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. 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.

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.

In conclusion, a CPA proposed action is not expected to adversely alter barrier beach configurations significantly 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.

Because of 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 less 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 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 the most current information did reveal that some of the barrier islands had experienced storm-induced reductions in beach shoreline elevations and erosion, the significance of this loss of protection is small in comparison with the overriding climatic forces. 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. 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.

Wetlands (Chapter 4.2.1.4)

It is expected that these 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.

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 either 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.

Seagrass Communities (Chapter 4.2.1.5)

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.

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 will decrease the detrimental effects to submerged vegetation from a CPA proposed action.

As noted in the **Chapter 4.2.1.5**, there remains uncertainty regarding the impacts of the DWH event on submerged vegetation. At least for submerged vegetation in Louisiana, 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 OCS activities of a CPA proposed action are expected to be minimal because of the distance of most activities from the submerged vegetation beds, because the 0-1 pipeline landfall and maintenance dredging are heavily regulated and permitted, because mitigations (such as turbidity curtains and siting away from beds) may be required, and because the likelihood of an accidental event of size, location, and duration reaching submerged vegetation spills remains small.

Live Bottoms (Chapter 4.2.1.6)

Live Bottoms (Pinnacle Trend) (Chapter 4.2.1.6.1)

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. 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 fluids 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. Toxic impacts on benthos are limited to within 100-200 m (328-656 ft) of a well, 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.

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.

Live Bottoms (Low Relief) (Chapter 4.2.1.6.2)

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. 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 fluids would be dispersed upon discharge. Toxic impacts on benthos are limited to within 100-200 m (328-656 ft) of a well, 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.

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.

Topographic Features (Chapter 4.2.1.7)

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. 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 long-term (10 years or more) adverse impacts to the biota of the topographic features.

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.

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. In most cases, recovery from disturbances would take 10 years or more. 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 will 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 long-term (10 years or more) adverse impacts to the biota of the topographic features.

Sargassum Communities (Chapter 4.2.1.8)

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.

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.

Chemosynthetic Deepwater Benthic Communities (Chapter 4.2.1.9)

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.

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. 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). 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, will 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.

Nonchemosynthetic Deepwater Benthic Communities (Chapter 4.2.1.10)

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.

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.

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, will 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.

Soft-Bottom Benthic Communities (Chapter 4.2.1.11)

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. 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.

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. 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, and impacts would be to an extremely small portion of the overall Gulf of Mexico.

Marine Mammals (Chapter 4.2.1.12)

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.

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 existing leases and related activities. As of November 2011, there are 4,503 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.

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. 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. These long-term impacts could have population-level effects.

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 reinitated consultation, with BSEE involvement. Consultation is ongoing at this time. As BOEM moves forward with this new 5-Year Program (2012-2017), BOEM and BSEE are developing a coordination and review processes 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 post-lease 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.

Sea Turtles (Chapter 4.2.1.13)

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.

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 of this EIS). 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 existing leases and related activities (there are 4,503 active leases in the CPA as of November 2011). 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.

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 are 4,503 active leases in the CPA, as of November 2011, 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.

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. For example, 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 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 November 2011, there are 4,503 active leases in the CPA proposed action area that are engaged, 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 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.

Diamondback Terrapins (Chapter 4.2.1.14)

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.

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 proposed action area as a result of existing leases and related activities. There are 4,503 active leases in the CPA as of November 2011. 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.

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 4,503 active leases (as of November 2011) 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.

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 November 2011, there are 4,503 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.

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, large-scale catastrophic event of the size and type that could reach these habitats is discussed in **Appendix B**.

Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice (Chapter 4.2.1.15)

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. 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.

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 (<0.5% probability), 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.

Coastal and Marine Birds (Chapter 4.2.1.16)

In general, the effects from routine activities in the CPA 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. 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. However, 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. Over the life of the GOM platform archipelago (a 40-year period), mortality estimates may be on the order of 7-12 million birds. 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 existing leases and related activities. 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; 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. However, avoidance measures and conditions are routinely placed on permitted activities to protect habitat.

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. 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.

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. Small amounts of oil can affect birds, and mortality from oil spills is often related to numerous symptoms of toxicity. Data from actual spills strongly suggest that impacts to a bird species' food supply are typically delayed after initial impacts from direct oiling. Sublethal, long-term effects of oil on birds have previously been documented, including changes to sexual signaling.

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**.

Gulf Sturgeon (Chapter 4.2.1.17)

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, explosive removal of structures, and pipeline installation. 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. Explosive removal of structures as a result of a CPA proposed action would occur well offshore of Gulf sturgeon's critical habitat and the riverine, estuarine, and shallow Gulf habitats where sturgeon are generally located. 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. 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.

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. 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. The probability for the occurrence of a spill of the size and duration required to impact the Gulf sturgeon critical habitat is low, ranging from 1 to 2 percent to 2 to 4 percent for a 10- or 30-day probability of exposure, respectively (**Figure 3-22**), from a CPA proposed action, unless the spill is catastrophic in nature such as the DWH event**)**. The probability for the occurrence of a spill in the WPA of the size and duration required to impact the Gulf sturgeon critical habitat is <0.5 percent (**Figure 3-22**), unless the spill is catastrophic in nature such as the DWH event (**Appendix B**). 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.

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.

Fish Resources and Essential Fish Habitat (Chapter 4.2.1.18)

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.

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.

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. 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. 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 of 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 of 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.

Commercial Fishing (Chapter 4.2.1.19)

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.

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.

Recreational Fishing (Chapter 4.2.1.20)

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.

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 noticeable 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.

Recreational Resources (Chapter 4.2.1.21)

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 coast of Texas. 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.

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, have effects that reach beyond the damaged area, effects to recreation and tourism could be significant.

Archaeological Resources (Chapter 4.2.1.22)

Historic (Chapter 4.2.1.22.1)

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, and dredging or pipeline project) 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.

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.

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.

Prehistoric (Chapter 4.2.1.22.2)

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, and dredging or pipeline project) 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. 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.

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.

Human Resources and Land Use (Chapter 4.2.1.23)

Land Use and Coastal Infrastructure (Chapter 4.2.1.23.1)

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. 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.

Accidental events associated with a CPA proposed action 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, high-impact 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. 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, high-impact 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.

Demographics (Chapter 4.2.1.23.2)

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.

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.

Economic Factors (Chapter 4.2.1.23.3)

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.

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.

Environmental Justice (Chapter 4.2.1.23.4)

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. In general, who would be hired and where new infrastructure might be located 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. 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 maintain 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.

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. Many of the long-term impacts of the DWH event to low-income and minority communities are 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. 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 affects. 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.

The DWH event was a low-probability, high-impact 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.

Species Considered due to U.S. Fish and Wildlife Concerns (Chapter 4.2.1.24)

Because of the mitigations likely to 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 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 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 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; therefore, a CPA proposed action would have no effect on the above-mentioned species. 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**).

2.4.1.3. Mitigating Measures

2.4.1.3.1. Topographic Features Stipulation

The topographic features located in the CPA provide habitat for coral-reef-community organisms (**Chapter 4.2.1.7**). These communities could be severely and adversely impacted by oil and gas activities resulting from a proposed action if such activities took place on or near these communities without the Topographic Features Stipulation and if such activities were not mitigated. The DOI has recognized this problem for some years, and since 1973 stipulations have been made a part of leases on or near these biotic communities so that impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation would not prevent the recovery of oil and gas resources but would serve to protect valuable and sensitive biological resources.

The Topographic Features Stipulation was formulated based on consultation with various Federal agencies and comments solicited from the States, industry, environmental organizations, and academic representatives. The stipulation is based on years of scientific information collected since the inception of the stipulation. This information includes various Bureau of Land Management/MMS (BOEM)-funded studies on the topographic highs in the CPA; numerous stipulation-imposed, industry-funded monitoring reports; and the National Research Council (NRC) report entitled *Drilling Discharges in the Marine Environment* (1983). The location and lease status of the blocks affected by the Topographic Features Stipulation are shown on **Figure 2-1**.

The requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer confines the effluent to a level deeper than that of the living reef of a high-relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high-relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NRC, 1983).

(b) The biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef-building activity (Rezak and Bright, 1981; Rezak et al., 1983 and 1985).

The stipulation establishes No Activity Zones at the topographic features. A zone is defined by the 85-m bathymetric contour (isobath) since, generally, the biota shallower than 85 m (279 ft) are more typical of the Caribbean reef biota, while the biota deeper than 85 m (279 ft) are similar to soft-bottom organisms found throughout the Gulf. Where a topographic feature is in water depths less than 85 m (279 ft), the deepest "closing" isobath defines the No Activity Zone for that area. Within the No Activity Zones, no operations, anchoring, or structures are allowed. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted.

The stipulation requires that all effluents within 1,000 m (3,281 ft) of banks containing an antipatharian-transitional zone be shunted to within 10 m (33 ft) of the seafloor. Banks containing the more sensitive and productive algal-sponge zone require a shunt zone extending 1 nmi (1.2 mi; 1.9 km) and an additional 3-nmi shunt zone for development only.

The stipulation reads as follows:

Topographic Features Stipulation

(a) No activity including structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the leases on banks as listed above.

(b) Operations within "1,000-Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

(c) Operations within "1-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom. (Where there is a "1-Mile Zone" designated, the "1,000-Meter Zone" in paragraph (b) is not designated.)

(d) Operations within "3-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

The banks and corresponding blocks to which this stipulation may be applied in the CPA are as follows:

Bank Name	Isobath (m)	Bank Name	Isobath (m)
McGrail Bank	85	Jakkula Bank	85
Bouma Bank	85	Sweet Bank[1]	85
Rezak Bank	85	Bright Bank	85
Sidner Bank	85	Geyer Bank	85
Sackett Bank[2]	85	Elvers Bank	85
Ewing Bank	85	Alderdice Bank	80
Diaphus Bank[2]	85	Fishnet Bank[2]	76
Parker Bank	85	Sonnier Bank	55

[1] Only paragraph (a) of the stipulation applies.
[2] Only paragraphs (a) and (b) of the stipulation apply.
[3] CPA bank with a portion of its "3-Mile Zone" in the WPA.

Effectiveness of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from adverse effects due to routine oil and gas activities. Such effects include physical damage from anchoring and rig emplacement and potential toxic and smothering effects from muds and cuttings discharges. The Topographic Features Stipulation has been used on leases since 1973, and this experience shows conclusively that the stipulation effectively prevents damage to the biota of these banks from routine oil and gas activities. Anchoring related to oil and gas activities on the sensitive portions of the topographic features has been prevented. Monitoring studies have demonstrated that the shunting requirements of the stipulations are effective in preventing the muds and cuttings from impacting the biota of the banks. The stipulation, if adopted for a proposed action, will continue to protect the biota of the banks, specifically as discussed below.

Mechanical damage resulting from oil and gas operations is probably the single most serious impact to benthic habitat. Complying with the No Activity Zone designation of the Topographic Features Stipulation should completely eliminate this threat to the sensitive biota of CPA topographic features from activities resulting from a proposed action. The sensitive biota within the zones provided for in the Topographic Features Stipulation will thus be protected.

Several other impact-producing factors may threaten communities associated with topographic features. Vessel anchoring and structure emplacement result in physical disturbance of benthic habitat and are the most likely activities to cause permanent or long-lasting impacts to sensitive offshore habitats. Recovery from damage caused by such activities may take 10 or more years (depending on the maturity of the impacted community). Operational discharges (drilling muds and cuttings, produced waters) may impact the biota of the banks due to turbidity and sedimentation, resulting in death to benthic organisms in large areas. Recovery from such damage may take 10 or more years (depending on the maturity of the impacted community). Blowouts may cause similar damage to benthic biota by resuspending sediments, causing turbidity and sedimentation, which could ultimately have a lethal impact on benthic organisms. Recovery from such damage may take up to 10 years (depending on the maturity of the impacted community). Oil spills will cause damage to benthic organisms if the oil contacts the organisms; such contact is unlikely except from spills from blowouts. There have been few blowouts in the GOM. Structure removal using explosives can result in water turbidity, redeposition of sediments, and explosive shock-wave impacts. Recovery from such damage could take more than 10 years (depending on the maturity of the impacted community). The above activities, especially bottom-disturbing activities, have the greatest potential to severely impact the biota of topographic features. Those activities having the greatest impacts are also those most likely to occur. A proposed action, without benefit of the Topographic Features Stipulation or comparable mitigation, is expected to have a severe impact on the sensitive offshore habitats of the topographic features.

The stipulation provides different levels of protection for banks in different categories as defined by Rezak and Bright (1981). The categories and their definitions are as follows:

Category A: zone of major reef-building activity; maximum environmental protection recommended;

Category B: zone of minor reef-building activity; environmental protection recommended;

Category C: zone of negligible reef-building activity, but crustose algae present; environmental protection recommended; and

Category D: zone of no reef-building or crustose algae; additional protection not necessary.

The stipulation requires that all effluents within 1,000 m (3,281 ft) of Sackett, Fishnet, and Diaphus Banks, categorized by Rezak and Bright (1981) as Category C banks, be shunted into the nepheloid layer; the potentially harmful materials in drilling muds will be trapped in the bottom boundary layer and will not move up the banks where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m (3,281 ft) from the bank is not expected to impact the biota.

The stipulation protects the remaining banks (Category A and B banks) with even greater restrictions. Surface discharge will not be allowed within 1 nmi (1.2 mi; 1.9 km) of these more sensitive banks. Surface discharges outside of 1 nmi (1.2 mi; 1.9 km) are not expected to impact the biota of the banks, as adverse effects from surface discharge are limited to 1,000 m (3,281 ft). However, it is possible that, when multiple wells are drilled from a single platform (surface location), typical during development operations, extremely small amounts of muds discharged more than 1 nmi (1.2 mi; 1.9 km) from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged during development drilling, the stipulation imposes a 3-Mile Zone within which shunting of development well effluent is required.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from a proposed action, while allowing the development of nearby oil and gas resources. The stipulation will not protect the banks from the adverse effects of an accident such as a large blowout on a nearby oil or gas operation.

2.4.1.3.2. Live Bottom (Pinnacle Trend) Stipulation

The Live Bottom (Pinnacle Trend) Stipulation covers the pinnacle trend area of the CPA (**Figure 2-1**). A small portion of the northeastern CPA sale area is characterized by a pinnacle trend, which is classified as a live bottom under the stipulation. The pinnacles are a series of topographic irregularities with variable biotal coverage, which provide structural habitat for a variety of pelagic fish. The pinnacles in the region could be impacted from physical damage of unrestricted oil and gas activities, as noted in **Chapter 4.2.1.6**. The Live Bottom (Pinnacle Trend) Stipulation is intended to protect the pinnacle trend and the associated hard-bottom communities from damage and, at the same time, provide for recovery of potential oil and gas resources. The stipulation reads as follows:

Live Bottom (Pinnacle Trend) Stipulation

> For the purpose of this stipulation, "live bottom areas" are defined as seagrass communities; or those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna.
>
> Prior to any drilling activities or the construction or placement of any structure for exploration or development on this lease, including, but not limited to, anchoring, well drilling, and pipeline and platform placement, the lessee will submit to the Regional Director (RD) a live bottom survey report containing a bathymetry map prepared utilizing remote sensing techniques. The bathymetry map shall be prepared for the purpose of determining the presence or absence of live bottoms which could be impacted by the proposed activity. This map shall encompass such an area of the seafloor where surface disturbing activities, including anchoring, may occur.
>
> If it is determined that the live bottoms might be adversely impacted by the proposed activity, the RD will require the lessee to undertake any measure deemed economically, environmentally, and technically feasible to protect the pinnacle area. These measures may include, but are not limited to, the following:
>
> a. the relocation of operations; and
>
> b. the monitoring to assess the impact of the activity on the live bottoms.

Effectiveness of the Lease Stipulation

Through detection and avoidance, this stipulation minimizes the likelihood of mechanical damage from OCS activities associated with rig and anchor emplacement to the sessile and pelagic communities associated with the crest and flanks of such features. Since this area is subject to heavy natural sedimentation, this stipulation does not include any specific measures to protect the pinnacles from the discharge of effluents.

The sessile and pelagic communities associated with the crest and flanks of the pinnacle and hard-bottom features could be adversely impacted by oil and gas activities resulting from a proposed action if such activities took place on or near these communities without the Live Bottom (Pinnacle Trend) Stipulation. For many years, this stipulation has been made a part of leases on blocks in the CPA on or near these biotic communities so that impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation does not prevent the recovery of oil and gas resources; however, it does serve to protect valuable and sensitive biological resources.

Activities resulting from a proposed action, particularly anchor damage to localized pinnacle areas, are expected to cause substantial damage to portions of the pinnacle trend environment because these activities are potentially destructive to the biological communities and could damage one or several individual pinnacles. The most potentially damaging of these are the impacts associated with mechanical damages that may result from anchors. However, the action is judged to be infrequent because of the limited operations in the vicinity of the pinnacles and the small size of many of the features. Minor impact is expected from large oil spills, blowouts, pipeline emplacement, muds and cuttings discharges, and structure removals. The frequency of impacts to the pinnacles is rare, and the severity is judged to be slight because of the widespread nature of the features within the pinnacle trend area. A proposed action, without the benefit of the Live Bottom (Pinnacle Trend) Stipulation, could have an adverse impact on the pinnacle region, but such impact is expected to be of a localized nature. Impact from mechanical damage including anchors could potentially be long term if the physical integrity of the pinnacles themselves became altered.

The pinnacle trend occurs as patchy regions within the general area of the eastern portion of the CPA (Ludwick and Walton, 1957; Barry A. Vittor and Associates, Inc., 1985; Brooks and Giammona, 1990). The pinnacle trend also extends into the EPA. The stipulation would require the operators to locate the individual pinnacles and associated communities that may be present in the block. The stipulation requires that a survey be done to encompass the potential area of proposed surface disturbance and that a bathymetry map depicting any pinnacles in the vicinity be prepared from the survey. (Since it is the pinnacles themselves and the habitat they provide for various species that are sensitive to impacts from oil and gas activities, photodocumentation of the identified pinnacles is not warranted.) The BOEM's Gulf of Mexico Regional Director, through consultation with FWS, could then decide if pinnacles in the trend would be potentially impacted and, if so, require appropriate mitigating measures.

By identifying the individual pinnacles present at the activity site, the lessee would be directed to avoid placement of the drilling rig and anchors on the sensitive areas. Thus, mechanical damage to the pinnacles is eliminated when measures required by the stipulation are imposed. The stipulation does not address the discharge of effluents near the pinnacles because the pinnacle trend is subjected to heavy natural sedimentation and is at considerable depths. The rapid dilution of drill cuttings and muds will minimize the potential of significant concentration of effluents on the pinnacles.

2.4.1.3.3. Military Areas Stipulation

See **Chapter 2.3.1.3.2** for a complete description of this stipulation.

2.4.1.3.4. Evacuation Stipulation

This stipulation would be a part of any lease in the easternmost portion of the CPA sale area resulting from a proposed action, i.e., Lease Sales 227, 231, 235, 241, and 247. An evacuation stipulation has been applied to all blocks leased in this area since 2001. The stipulation reads as follows:

Evacuation Stipulation

(a) The lessee, recognizing that oil and gas resource exploration, exploitation, development, production, abandonment, and site cleanup operations on the leased area of submerged lands may occasionally interfere with tactical military operations, hereby recognizes and agrees that the United States reserves and has the right to temporarily suspend operations and/or require evacuation on this lease in the interest of national security. Such suspensions are considered unlikely in this area. Every effort will be made by the appropriate military agency to provide as much advance notice as possible of the need to suspend operations and/or evacuate. Advance notice of fourteen (14) days shall normally be given before requiring a suspension or evacuation, but in no event will the notice be less than four (4) days. Temporary suspension of operations may include the evacuation of personnel, and appropriate sheltering of personnel not evacuated. Appropriate shelter shall mean the protection of all lessee personnel for the entire duration of any Department of Defense activity from flying or falling objects or substances and will be implemented by a written order from the BSEE Regional Supervisor for Field Operations (RS-FO), after consultation with the appropriate command headquarters or other appropriate military agency, or higher authority. The appropriate command headquarters, military agency or higher authority shall provide information to allow the lessee to assess the degree of risk to, and provide sufficient protection for, lessee's personnel and property. Such suspensions or evacuations for national security reasons will not normally exceed seventy-two (72) hours; however, any such suspension may be extended by order of the RS-FO. During such periods, equipment may remain in place, but all production, if any, shall cease for the duration of the temporary suspension if so directed by the RS-FO. Upon cessation of any temporary suspension, the RS-FO will immediately notify the lessee such suspension has terminated and operations on the leased area can resume.

(b) The lessee shall inform the BOEM of the persons/offices to be notified to implement the terms of this stipulation.

(c) The lessee is encouraged to establish and maintain early contact and coordination with the appropriate command headquarters, in order to avoid or minimize the effects of conflicts with potentially hazardous military operations.

(d) The lessee shall not be entitled to reimbursement for any costs or expenses associated with the suspension of operations or activities or the evacuation of property or personnel in fulfillment of the military mission in accordance with subsections (a) through (c) above.

(e) Notwithstanding subsection (d), the lessee reserves the right to seek reimbursement from appropriate parties for the suspension of operations or activities or the evacuation of property or personnel associated with conflicting commercial operations.

Effectiveness of the Lease Stipulation

This stipulation would provide for evacuation of personnel and shut-in of operations during any events conducted by the military that could pose a danger to ongoing oil and gas operations. It is expected that the invocation of these evacuation requirements will be extremely rare.

It is expected that these measures will serve to eliminate dangerous conflicts between oil and gas operations and military operations. Continued close coordination between BSEE and the military may result in improvements in the wording and implementation of these stipulations.

2.4.1.3.5. Coordination Stipulation

This stipulation would be a part of any lease in the easternmost portion of the CPA sale area resulting from a proposed action, i.e., Lease Sales 227, 231, 235, 241, and 247. A coordination stipulation has been applied to all blocks leased in this area since 2001. The stipulation reads as follows:

Coordination Stipulation

(a) The placement, location, and planned periods of operation of surface structures on this lease during the exploration stage are subject to approval by the BSEE Regional Director (RD) after the review of an operator's EP. Prior to approval of the EP, the lessee shall consult with the appropriate command headquarters regarding the location, density, and the planned periods of operation of such structures, and to maximize exploration while minimizing conflicts with Department of Defense activities. When determined necessary by the appropriate command headquarters, the lessee will enter a formal Operating Agreement with such command headquarters, that delineates the specific requirements and operating param for the lessee's Final activities in accordance with the military stipulation clauses contained herein. If it is determined that the Final operations will result in interference with scheduled military missions in such a manner as to possibly jeopardize the national defense or to pose unacceptable risks to life and property, then the RD may approve the EP with conditions, disapprove it, or require modification in accordance with 30 CFR 550. The RD will notify the lessee in writing of the conditions associated with plan approval, or the reason(s) for disapproval or required modifications. Moreover, if there is a serious threat of harm or damage to life or property, or if it is in the interest of national security or defense, pending or approved operations may be suspended in accordance with 30 CFR 250. Such a suspension will extend the term of a lease by an amount equal to the length of the suspension, except as provided in 30 CFR 250.169(b). The RD BSEE will attempt to minimize such suspensions within the confine of related military requirements. It is recognized that the issuance of a lease conveys the right to the lessee as provided in section 8(b)(4) of the Outer Continental Shelf Lands Act to engage in exploration, development, and production activities conditioned upon other statutory and regulatory requirements.

(b) The lessee is encouraged to establish and maintain early contact and coordination with the appropriate command headquarters, in order to avoid or minimize the effects of conflicts with potentially hazardous military operations.

(c) If national security interests are likely to be in continuing conflict with an existing operating agreement, the RD will direct the lessee to modify any existing operating agreement or to enter into a new operating agreement to implement measures to avoid or minimize the identified potential conflicts, subject to the terms and conditions and obligations of the legal requirements of the lease.

Effectiveness of the Lease Stipulation

This stipulation would provide for review of pending oil and gas operations by military authorities and could result in delaying oil and gas operations if military activities have been scheduled in the area that may put the oil and gas operations and personnel at risk.

2.4.1.3.6. Blocks South of Baldwin County, Alabama, Stipulation

This stipulation will be included only on leases on blocks south of and within 15 mi (24 km) of Baldwin County, Alabama. The stipulation reads as follows:

Blocks South of Baldwin County, Alabama, Stipulation

In order to minimize visual impacts from development operations on this block, you will contact lessees and operators of leases in the vicinity prior to submitting a Development Operations Coordination Document (DOCD) to determine if existing or planned surface production structures can be shared. If feasible, your DOCD should reflect the results of any resulting sharing agreement, propose the use of subsea technologies, or propose another development scenario that does not involve new surface structures.

If you cannot formulate a feasible development scenario that does not call for new surface structure(s), your DOCD should ensure that they are the minimum necessary for the proper development of the block and that they will be constructed and placed, using orientation, camouflage, or other design measures, to limit their visibility from shore.

The BOEM will review and make decisions on your DOCD in accordance with applicable Federal regulations and BOEM policies, and in consultation with the State of Alabama (Geological Survey/Oil and Gas Board).

Effectiveness of the Lease Stipulation

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, the BOEM, 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 5--Year Programs.

2.4.1.3.7. Protected Species Stipulation

See **Chapter 2.3.1.3.3** for a complete description of this stipulation.

2.4.1.3.8. Law of the Sea Convention Royalty Payment Stipulation

See **Chapter 2.3.1.3.4** for a complete description of this stipulation.

2.4.2. Alternative B—The Proposed Action Excluding the Unleased Blocks Near the Biologically Sensitive Topographic Features

2.4.2.1. Description

Alternative B differs from Alternative A by not offering the blocks that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.4.1.3.1** and **Figure 2-1)**. All of the assumptions (including the seven other potential mitigating measures; Law of the Sea Convention Royalty Payment Stipulation is not a mitigation) and estimates are the same as for Alternative A. A description of Alternative A is presented in **Chapter 2.4.1.1**.

2.4.2.2. Summary of Impacts

The analyses of impacts summarized in **Chapter 2.4.1.2** and described in detail in **Chapter 4.2** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapter 3**.

The difference between the potential impacts described for Alternative A and those under Alternative B is that under Alternative B no oil and gas activity would take place in the blocks subject to the Topographic Features Stipulation (**Figure 2-1**). The number of blocks that would not be offered under Alternative B represents only a small percentage of the total number of blocks to be offered under Alternative A; therefore, it is assumed that the levels of activity for Alternative B would be essentially the same as those projected for a proposed action. As a result, the impacts expected to result from Alternative B would be very similar to those described under the proposed action (**Chapter 4.2**). Therefore, the regional impact levels for all resources, except for the topographic features, would be similar to those described under the proposed action. This alternative, if adopted, would prevent any oil and gas activity in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks.

2.4.3. Alternative C—No Action

2.4.3.1. Description

Alternative C is the cancellation of a proposed CPA lease sale. The opportunity for development of the estimated 0.460-0.894 BBO and 1.939-3.903 Tcf of gas **(Table 3-1**) that could have resulted from a proposed lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed.

2.4.3.2. Summary of Impacts

Canceling a proposed lease sale would eliminate the effects described for Alternative A (**Chapter 4.2**). The incremental contribution of a proposed lease sale to cumulative effects would also be avoided, but effects from other activities, including other OCS lease sales, would remain.

If a 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. Therefore, the cancellation of a proposed lease sale would not significantly change the environmental impacts of overall OCS activity. However, the cancellation of a lease sale may result in direct economic impacts to the individual companies. Revenues collected by the Federal Government (and thus revenue disbursements to the States) would be adversely affected also.

Other sources of energy may substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have negative environmental impacts of their own.

CHAPTER 3

IMPACT-PRODUCING FACTORS AND SCENARIO

3. IMPACT-PRODUCING FACTORS AND SCENARIO

3.1. IMPACT-PRODUCING FACTORS AND SCENARIO—ROUTINE OPERATIONS

3.1.1. Offshore Impact-Producing Factors and Scenario

This section describes the offshore infrastructure and activities (impact-producing factors) associated with the WPA and CPA proposed actions (i.e., a typical lease sale that would result from the proposed actions) within the WPA and CPA that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico. In addition, this section describes the OCS Program cumulative activity scenario resulting from past and future lease sales in the WPA, CPA, and EPA that could potentially affect the biological, physical, and socioeconomic resources of the GOM within the WPA and CPA. Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical lease sale that would result from the proposed actions within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA will be disclosed in a subsequent EIS.

Offshore is defined here as the OCS portion of the GOM that begins 10 mi (16 km) offshore Florida; 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama; and 3 leagues (10.3 mi; 16.5 km) offshore Texas; and it extends seaward to the limits of the United States jurisdiction over the continental shelf in water depths up to approximately 3,346 m (10,978 ft), the Exclusive Economic Zone (**Figure 1-1**). Coastal infrastructure and activities associated with the WPA and CPA proposed actions are described in **Chapter 3.1.2**.

Offshore activities are described in the context of scenarios for the proposed actions and for the OCS Program within the WPA and CPA. The BOEM's Gulf of Mexico OCS Region developed these scenarios to provide a framework for detailed analyses of potential impacts of the proposed lease sales. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production activities and facilities, both offshore and onshore. Each proposed action, a typical sale, is represented by a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors, and it is expected to be within the scenario ranges. The scenarios do not predict future oil and gas activities with absolute certainty, even though they were formulated using historical information and current trends in the oil and gas industry. Indeed, these scenarios are only approximate since future factors such as the contemporary economic marketplace, the availability of support facilities, and pipeline capacities are all unknowns. Notwithstanding these unpredictable factors, the scenarios used in this EIS represent the best assumptions and estimates of a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses. The development scenarios do not represent a BOEM recommendation, preference, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities.

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.

The BOEM uses a series of spreadsheet based data analyses tools to develop the forecasts of oil and gas exploration, discovery, development, and production activity for the proposed actions and OCS Program scenarios presented in this EIS. Our analyses incorporate all relevant historical activity and infrastructure data, and our resulting forecasts are analyzed and compared with actual historical data to ensure that historical precedent and recent trends are reflected in each activity forecast.

The BOEM is confident that our analysis methodology, with adjustments and refinements based on recent activity levels, adequately project Gulf of Mexico OCS activities in both the short term and the long term for the EIS analyses.

The WPA and CPA proposed actions and the Gulfwide OCS Program scenarios are based on the following factors:

- recent trends in the amount and location of leasing, exploration, and development activity;
- estimates of undiscovered, unleased, economically recoverable oil and gas resources in each water-depth category and each planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- published data and information;
- industry information; and
- oil and gas technologies, and the economic considerations and environmental constraints of these technologies.

The proposed lease sales within the Gulf of Mexico OCS are WPA Lease Sales 229, 233, 238, 246, and 248; CPA Lease Sales 227, 231, 235, 241, and 247; and EPA Lease Sales 225 and 226. In general, each of the WPA proposed lease sales represents 4-5 percent of the OCS Program in the WPA based on barrels of oil equivalent (BOE) resource estimates and 1 percent of the total OCS Program. The proposed CPA lease sales each represent 3-4 percent of the OCS Program in the CPA (1% of the total OCS Program). Activities associated with the proposed actions are assumed to represent those same percentages of OCS Program activities unless otherwise indicated.

Specific projections for activities associated with a proposed action are discussed in the following scenario sections. The potential impacts of the activities associated with a proposed "typical" lease sale are considered in the environmental analysis sections (**Chapters 4.1 and 4.2**).

The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the analysis period. This includes projected activity from lease sales that have been held, including the most recent CPA Lease Sale 213 (March 2010), but for which exploration or development has either not yet begun or is continuing. Activities that take place beyond the analysis timeframe as a result of future lease sales are not included in this analysis. The impacts of activities associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the cumulative environmental analysis sections (**Chapters 4.1 and 4.2**).

3.1.1.1. Resource Estimates and Timetables

3.1.1.1.1. Proposed Actions

The proposed actions scenarios are used to assess the potential impacts of a proposed "typical" lease sale. The resource estimates for a proposed action are based on two factors: (1) the conditional estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the proposed lease sale areas; and (2) estimates of the portion or percentage of these resources assumed to be leased, discovered, developed, and produced as a result of a proposed action. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results were reported as a range of values corresponding to different probabilities of occurrence. The estimates of the portion of the resources assumed to be leased, discovered, developed, and produced as a result of a proposed action are based upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. A profusion of historical databases and information derived from oil and gas exploration and development activities are available to BOEM and were used extensively. The undiscovered, unleased, conventionally recoverable resource estimates for a proposed action are expressed as ranges, from low to high. This range provides a reasonable expectation of oil and gas production anticipated from typical lease sales held as a result of a proposed action based on an actual range of historic observations.

Table 3-1 presents the projected oil and gas production for the proposed actions and for the OCS Program. **Tables 3-2 and 3-3** provide a summary of the major scenario elements of the proposed actions and some of the related impact-producing factors. To analyze impact-producing factors for the proposed actions and the OCS Program, the proposed lease sale areas were divided into offshore subareas based upon ranges in water depth. **Figure 3-1** depicts the location of the offshore subareas. The water-depth ranges reflect the technological requirements and related physical and economic impacts as a consequence of the oil and gas potential, exploration and development activities, and lease terms unique to each water-depth range. Estimates of resources and facilities are distributed into each of the subareas.

Proposed Action Scenarios (WPA and CPA Typical Sales): The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a typical proposed WPA lease sale are 0.116-0.200 BBO and 0.538-0.938 Tcf of gas. The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed CPA lease sale are 0.460-0.894 BBO and 1.939-3.903 Tcf of gas. The impact-producing factors, affected environment, and environmental consequences related to proposed lease sales in the EPA will be disclosed and addressed in a subsequent Eastern Planning Area EIS within this 5-Year Program.

The number of exploration and delineation wells, production platforms, and development wells projected to develop and produce the estimated resources for a WPA and CPA proposed action are given in **Tables 3-2 and 3-3**, respectively. The tables show the distribution of these factors by offshore subareas in the proposed lease sale areas. **Tables 3-2 and 3-3** also include estimates of the major impact-producing factors related to the projected levels of exploration, development, and production activity.

Exploratory drilling activity takes place over an 8-year period, beginning within 1 year after the lease sale. Development activity takes place over a 39-year period, beginning with the installation of the first production platform and ending with the drilling of the last development wells. Production of oil and gas begins by the third year after the lease sale and continues beyond the 40th year.

3.1.1.1.2. OCS Program

OCS Program Cumulative Scenario (WPA, CPA, and EPA): Projected reserve/resource production for the OCS Program is 18.335-25.64 BBO and 75.886-111.627 Tcf of gas and represents anticipated production from lands currently under lease plus anticipated production from future lease sales over the 40-year analysis period. The OCS Program cumulative scenario includes WPA, CPA, and EPA production estimates. **Table 3-4** presents projections of the major activities and impact-producing factors related to future Gulfwide OCS Program activities.

WPA Cumulative Scenario: Projected reserve/resource production for the OCS Program in the WPA (2.510-3.696 BBO and 12.539-18.434 Tcf of gas) represents anticipated production from lands currently under lease in the WPA plus anticipated production from future WPA lease sales over the 40-year analysis period. Projected production represents approximately 14 percent of the oil and 17 percent of the gas of the total Gulfwide OCS Program. **Table 3-5** presents projections of the major activities and impact-producing factors related to future operations in the WPA.

CPA Cumulative Scenario: Projected reserve/resource production for the OCS Program in the CPA (15.825-21.733 BBO and 63.347-92.691 Tcf of gas) represents anticipated production from lands currently under lease in the CPA plus anticipated production from future CPA lease sales over the 40-year analysis period. Projected production represents approximately 85-86 percent of the oil and 83 percent of the gas of the total Gulfwide OCS Program. **Table 3-6** presents projections of the major activities and impact-producing factors related to future operations in the CPA.

EPA Cumulative Scenario: Projected reserve/resource production for the OCS Program in the EPA (0-0.211 BBO and 0-0.502 Tcf of gas) represents anticipated production from lands currently under lease in the EPA plus anticipated production from future EPA lease sales over the 40-year analysis period. Projected production represents approximately 1 percent of the oil and >1 percent of the gas of the total Gulfwide OCS Program. The impact-producing factors, affected environment, and environmental consequences related to proposed lease sales within the EPA will be disclosed and addressed in a subsequent Eastern Planning Area EIS within this 5-Year Program.

3.1.1.2. Exploration and Delineation

3.1.1.2.1. Seismic Surveying Operations

Prelease surveys are comprised of seismic work performed on or off leased areas, focused most commonly (but not always) on deeper targets and collectively authorized under BOEM's geological and geophysical permitting process. Postlease, high-resolution seismic surveys collect data on surficial or near-surface geology used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as chemosynthetic community habitat, gas hydrates, buried channels and faults, and archaeological resources. High-resolution surveys are conducted as authorized under the terms and conditions of the lease agreement (see BOEM's regulations at 30 CFR 550.207). Other postlease surveys include downhole seismic surveying (vertical seismic profiling [VSP]) and time-lapse, deep-focused, 3-dimensional (3D) surveying (4D surveys) used for reservoir monitoring.

All seismic surveying constitutes a type of remote sensing. Typical prelease seismic surveying operations for exploring deep geologic formations typically are 2D or 3D. A tow vessel pulls an array of airguns and streamers (acoustic receiver cable) behind the vessel 5-10 m (16-33 ft) below the sea surface. Ocean-bottom systems may be deployed instead of streamers in shallow water, areas of dense infrastructure, or when 4D seismic is used to aid in reservoir management. This methodology utilizes hydrophones placed statically on the seafloor. The energy source (airgun arrays) remains the same as streamer methods and is towed behind a source vessel. The airgun array produces a burst of underwater sound by releasing compressed air into the water column, creating an acoustical energy pulse the echoes of which are detected by hydrophones towed on streamers behind the vessel. Streamer arrays are 3-8 mi (5-12 km) or greater in length, depending on survey specifications. Tow vessel speed is typically 3-5 knots (kn) (about 4-6 miles per hour [mph]) with gear deployed.

The 3D surveys conducted by seismic contractors can consist of a few to several hundred OCS blocks. Multiple source and multiple-streamer technologies are often used for 3D seismic surveys. For a typical 3D survey, air in a closed chamber of the airgun is quickly discharged through a port, creating a pressure pulse and air bubble in the water. To release more energy into the pressure pulse and to offset the deleterious effects of bubble oscillations on the pressure pulse, multiple airguns with various chamber sizes are used. These individual airgun chamber sizes vary from 20 to 380 in^3 (327 to 6,227 cm^3). In some cases, two or three airguns are placed in a cluster to increase the effective chamber size. The individual airguns are suspended in the water from a float system referred to as a sub-array. Each sub-array contains six or seven individual airguns spaced from 2.5 to 3 m (7.5 to 10 ft) apart, making the total sub-array length 14-17 m (46-56 ft) long. Typically, three (sometimes four) sub-arrays are combined to form an array. When three sub-array elements are used, the spacing is 8 m (26 ft) between sub-arrays; when four sub-arrays are used, the spacing is 12 m (39 ft). Thus, the overall width of the array is generally 16-36 m (52-118 ft). The array is towed at an approximate depth of 5-7 m (16-23 ft) below the water surface. Newer acquisition technology involves multiple vessels towing airgun arrays with additional vessels towing streamers. These 3D wide azimuth (WAZ) surveys increase the illumination of many subsurface areas, particularly areas that are overlain with salt, and eliminate unwanted noise attenuation. The 3D coil surveys are a navigational variation of WAZ surveys and are acquired in a spiral fashion that allows for a longer acoustical distance between source and receivers for a better illumination of the acquired data.

A 4D or time-lapse survey is used to monitor how a reservoir drains to optimize the amount of hydrocarbon recovered. These surveys consist of a series of 3D surveys collected over time under the same acquisition and receiving parameters.

The VSP is usually done by placing a receiver down a wellbore at different depths and with an external acoustic source near the wellbore (zero-offset VSP) or on a vessel at different distances from the wellbore (called a walk-away VSP). These surveys are used to obtain information about the nature of the seismic signal, as well as more information about the geology surrounding the vertical array of sensors. The VSP data can be cross-correlated with ship-towed seismic survey datasets to refine identification of lithologic changes and the content of formation fluids. Zero offset and walk-away VSP surveys are by far and away the most common VSP surveys conducted in the GOM.

Ocean-Bottom Surveys

Ocean-bottom cable surveys were originally designed to enable seismic surveys in congested geographical areas, such as producing fields, with their many platforms and producing facilities. Autonomous nodes, deployed and retrieved by either cable or ROV's, are now used as an alternative to cables. The ocean-bottom cable surveys have been found to be useful for obtaining 4-component data or multicomponent (i.e., seismic pressure, vertical, and the two horizontal motions of the water bottom, or seafloor) information.

The ocean-bottom cable surveys and nodal acquisition require the use of multiple ships (i.e., usually two ships for cable or node layout/pickup, one ship for recording, one ship for shooting, and two utility boats). These ships are generally smaller than those used in streamer operations, and the utility boats can be very small. Operations are conducted "around the clock" and begin by dropping the cables off the back of the layout boat or by deployment of the nodal receivers by remotely operated vehicles (ROV's). Cable length or the numbers of nodes depend upon the survey demands; it is typically 2.6 mi (4.2 km) but can be up to 7.5 mi (12 km). However, depending on spacing and survey size, hundreds of nodes can be deployed and re-deployed over the span of the survey. Groups of seismic detectors, usually hydrophones and vertical motion geophones, are attached to the cable in intervals of 82-164 ft (25-50 m), or autonomous nodes are spaced similarly. Multiple cables/nodes are laid parallel to each other using this layout method, with a 164-ft (50-m) interval between cables/nodes. Typically, dual airgun arrays are used on a single source vessel. When the cable/node is in place, a ship towing an airgun array (which is the same airgun array used for streamer work) passes between the cables/nodes, firing every 82 ft (25 m). Sometimes a faster source ship speed of 7 mph (6 kn), instead of the normal speed of 5.2 mph (4.5 kn), is used with a decrease in time between gun firings. After a source line is shot, the source ship takes about 10-15 minutes to turn around and pass down between the next two cables or line of nodes. When a cable/node is no longer needed to record seismic data, it is picked up by the cable pickup ship and is moved over to the next position where it is needed. The nodes are retrieved by an ROV. A particular cable/node can lay on the bottom anywhere from 2 hours to several days, depending on operation conditions. Normally, a cable will be left in place about 24 hours. However, nodes may remain in place until the survey is completed or recovered and then re-deployed by an ROV.

Location of the cables/nodes on the bottom is done by acoustic pingers located at the detector groups and by using the time of first arrival of the seismic pulse at the detector group. A detector group is a node or group of nodes that enable the seismic ship to accurately determine node location. To obtain more accurate first arrival times, the seismic data are recorded with less electronic filtering than is normally used. This detailed location is combined with normal global positioning system (GPS) navigational data collected on the source ship. In deep water, the process of accurately locating bottom cables/nodes is more difficult because of the effects of irregular water bottoms and the thermal layers, which affect travel times and travel paths, thus causing positioning errors.

As part of the environmental impact analysis required with the EP, DOCD, or DPP, 30 CFR 550.227(b)(6) and 30 CFR 550.261(b)(6) require the applicant to submit archaeological information. In certain circumstances, the BOEM or BSEE Regional Directors may require the preparation of an archaeological report to accompany the EP, DOCD, or DPP under 30 CFR 250.194(c) and 550.194(c). The requirements for archaeological reports are clarified in NTL's 2005-G07 and 2008-G20, "Archaeological Resource Surveys and Reports" and "The Revisions to the List of OCS Lease Blocks Requiring Archaeological Resource Surveys and Reports," respectively. If the archaeological report, where required, indicates that an archaeological resource may be present, the lessee must either locate the site of any operation so as not to adversely affect the area where the archaeological resource may be, demonstrate that an archaeological resource does not exist, or demonstrate that archaeological resources will not be adversely affected by operations. If the lessee discovers any archaeological resource while conducting approved operations, operations must be immediately stopped and the discovery reported to the BOEM's Regional Supervisor, Office of Environment, within 48 hours of its discovery.

Proposed Action Scenario (WPA, CPA, and EPA Typical Sales): Because of the cyclic nature in acquisition of seismic surveys, a prelease seismic survey would be attributable to lease sales held up to 7-9 years after the survey. Based on an amalgam of historical trends in G&G permitting and industry input for the Gulf of Mexico G&G Programmatic EIS, BOEM projects that the proposed actions, i.e., the proposed lease sales, would result in 29,197 OCS blocks surveyed by deep seismic operations for the years 2012-2017. For postlease seismic surveys, information obtained from high-resolution seismic contractors operating in the GOM project the proposed actions would result in about 50 VSP operations and 629 high-resolution surveys covering approximately 226,400 line miles (364,420 km) of near-surface and shallow penetration seismic during the life of the proposed actions. The impact-producing factors, affected environment, and environmental consequences related to proposed lease sales in the EPA will be disclosed and addressed in a subsequent Eastern Planning Area EIS within this 5-Year Program.

OCS Program Cumulative Scenario: Seismic surveys are projected to follow the same trend as exploration activities, which peaked in 2008-2010, steadily decline until 2027, and remain relatively steady throughout the second half of the 40-year analysis period. It is important to note that the cycling of G&G data acquisition is not driven by the 40-year life cycle of productive leasing, but instead will trend to respond to new production or potential new production driven by new technology. Consequently, some areas will be resurveyed in 2-year cycles, while other areas, considered nonproductive, may not be surveyed for 20 years or more.

During the first 5 years of the analysis period, BOEM projects annually there would be 50 VSP operations, 226,400 lines miles (364,420 km) surveyed by high-resolution seismic, and 29,197 blocks surveyed by deep seismic, including some areas that will be resurveyed. During the second half of the 40-year analysis period, it is projected annually there would be 5-10 VSP operations, 40,000 mi (64,374 km) surveyed by high-resolution seismic, and 4,000-5,000 blocks surveyed by deep seismic.

3.1.1.2.2. Exploration and Delineation Plans and Drilling

Oil and gas operators use drilling terms that represent stages in the discovery and exploitation of hydrocarbon resources. An exploration well generally refers to the first well drilled on a prospective geologic structure to confirm that a resource exists and to validate how much resource can be expected. If a resource is discovered in quantities appearing to be economically viable, one or more follow-up delineation wells help define the amount of resource or the extent of the reservoir. Following a discovery, an operator will often temporarily plug and abandon a discovery to allow time for a development scenario to be generated and for equipment to be built or procured.

In the GOM, exploration and delineation wells are typically drilled with MODU's; e.g., jack-up rigs, semisubmersible rigs, submersible, platform rigs, or drill ships. Non-MODU drilling units, such as inland barges, are also used. The type of rig chosen to drill a prospect depends primarily on water depth. Because the water-depth ranges for each type of drilling rig overlap to a degree, other factors such as availability and daily rates play a large role when an operator decides upon the type of rig to contract. The depth ranges for exploration rigs used in this analysis for Gulf of Mexico MODU's are indicated below.

MODU or Drilling Rig Type	Water Depth Range
Jack-up, submersible, and inland barges	≤100 m
Semisubmersible and platform rig	100-3,000 m
Drillship	≥600 m

Historically, drilling rig availability has been a limiting factor for activity in the Gulf and is assumed to be a limiting factor for activity projected as a result of a proposed lease sale. Drilling activities may also be constrained by the availability of rig crews, shore-base facilities, risers, and other equipment.

The scenarios for the proposed actions assume that an average exploration/well will require 30-45 days to drill. The actual time required for each well depends on a variety of factors, including the depth of the prospect's potential target zone, the complexity of the well design, and the directional offset of the wellbore needed to reach a particular zone. This scenario assumes that the average exploration or delineation well depth will be approximately 3,674 m (12,055 ft) below mudline.

Some delineation wells may be drilled using a sidetrack technique. In sidetracking a well, a portion of the existing wellbore is plugged back to a specific depth, directional drilling equipment is installed, and a new wellbore is drilled to a different geologic location. The lessee may use this technology to better understand their prospect and to plan future wells. Use of this technology may also reduce the time and exploration expenditures needed to help evaluate the prospective horizons on a new prospect.

The cost of an ultra-deepwater well (>6,000 ft [1,829 m] water depth) can be $30-$50 million or more, without certainty that objectives can be reached. Some recent ultra-deepwater exploration wells in the GOM have been reported to have cost upwards of $100 million.

Figure 3-2 represents a generic well schematic for a relatively shallow exploration well in the deepwater GOM. This well design was abstracted from actual well-casing programs from projects in the Mississippi Canyon and De Soto Canyon OCS areas and from internal BOEM data. A generic well configuration cannot capture all of the possible influences that impact how a well is designed. These influences include (1) unique geologic conditions at a specific well location, (2) directional drilling requirements, (3) potential sidetrack(s), or (4) company preferences. For exploratory wells, contingencies (such as anticipated water-flow zones in the formation) must also be considered in the casing program.

The threshold separating shallow- and deepwater drilling can range from 200 to 457 m (656 to 1,500 ft). For exploration and development, deepwater is defined as water ≥305 m (≥1,000 ft) deep and ultra-deepwater as ≥1,524 m (≥5,000 ft) deep. The drilling (spudding) of a deepwater exploration well begins with setting the conductor casing, one of the many sections or strings of casing (steel tube) installed in the wellbore. Each casing section is narrower (of a smaller diameter) than the preceding one, and each change in casing diameter is separated by a "shoe" (**Figure 3-2)**. The drillstring (pipe, collar, and bit) drills the wellbore, and the casing is installed at certain depths within the well based on specific engineering and geologic criteria. The first casing set in the sea bottom (or mudline) can be large, approximately 30-40 in (75-100 cm) in diameter. The larger diameter pipe may be necessary when drilling through salt to reach subsalt objectives because more casing strings may be needed to reach the well's objective. The first string is emplaced by drilling or "jetting" out the unconsolidated sediment with a water jet as the largest casing pipe is set in place. The casing is cemented to the sea bottom and tested. Because the shallow sediments are frequently soft and unconsolidated, the next casing interval (1,000 ft [305 m] or more below mudline) is commonly drilled with treated seawater and without a riser (a steel-jacketed tube that connects the wellhead to the drill rig and within which the drilling mud and cuttings circulate). Drilling mud is generally not used when a riser is included in the system. The formation cuttings are discharged from the wellbore directly to the sea bottom. After the conductor casing is set a blowout preventer (BOP) is installed, commonly at the sea bottom, the riser is connected, and circulation for drilling muds and cuttings between the well bit and the surface rig is established.

Next, a repetitive procedure takes place until the well reaches its planned total depth: (1) drill to the next casing point; (2) install the casing; (3) cement the casing; (4) test the integrity of the seal; and (5) drill through the cement shoe and downhole until the next casing point is reached and a narrower casing string is then set. The casing points are determined by downhole formation pressure that is predicted before drilling with seismic wave velocities and by geological information from surrounding wells. As the well deepens, extra lengths of pipe (each about 100 ft [30 m] long) are screwed onto the drill string at the rig floor to extend the length to the cutting bit. As a drill bit wears out from use, it must be replaced. The drilling downtime needed to retrieve the bit and replace it requires the drill string to be disassembled and reassembled. This process is referred to as "tripping" into or out of the hole. "Tripping" will also occur when a casing point is reached. The drill string is removed, the casing is "run" and cemented in the wellbore, the drill string is re-run into the wellbore, and drilling continues. The bottommost portion of a well is commonly left "open" (uncased) when the well reaches its total depth.

As drilling activities occur in progressively deeper waters, operators may consider using MODU's that have onboard hydrocarbon storage capabilities. This option may be exercised if a well requires extended flow testing, 1-2 weeks or longer, in order to fully evaluate potential producible zones and to justify the higher costs of deepwater development activities. The liquid hydrocarbons resulting from an extended well test could be stored onboard a rig and later transported to shore for processing. Operators may also consider barge shuttling hydrocarbons from test well(s) to shore. There are some dangers inherit with barging operations if adverse weather conditions develop during testing. If operators do not choose to store produced liquid hydrocarbons during the well testing, they must request and receive approval from BSEE to burn test hydrocarbons. The BSEE will only grant permission to flare or vent associated natural gas during well cleanup and for well-testing procedures for a limited period of time.

The BSEE regulations require that operators conduct their offshore operations in a safe manner. Subpart D of BSEE's regulations (30 CFR 250) specifies requirements for drilling activities. See **Chapter 1.3.1** and **Table 1-2**, which provide a summary of new safety requirements.

Exploration Plans

The regulation at 30 CFR 550 Subpart B specifies the requirements for the exploration plans (EP's) that operators must submit to BOEM for approval prior to deploying an exploration program. An EP must be submitted to BOEM for review and decision before any exploration activities, except for preliminary activities, can begin on a lease. The EP describes exploration activities, drilling rig or vessel, proposed drilling and well-testing operations, environmental monitoring plans, oil-spill response plans, and other relevant information, and it includes a proposed schedule of the exploration activities. Guidelines and environmental information requirements for lessees and operators submitting an EP are addressed in 30 CFR 250.211 and are further explained in NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," and in NTL 2009-G27, "Submitting Exploration Plans and Development Operations Coordination Documents." The requirements for shallow-hazard surveys and their reports are clarified in NTL 2008-G05, "Shallow Hazards Program."

As part of the environment impact analysis required with a EP, DOCD, or DPP, 30 CFR 550.227(b)(6) and 30 CFR 550.261(b)(6) require the applicant to submit archaeological information. In certain circumstances, the BOEM or BSEE Regional Directors may require the preparation of an archaeological report to accompany the EP, DOCD, or DPP, under 30 CFR 250.194(c) and 550.194(c). The requirements for archaeological reports are clarified in NTL's 2005-G07 and 2008-G20, "Archaeological Resource Surveys and Reports" and "Revisions to the List of OCS Lease Blocks Requiring Archaeological Resource Surveys and Reports," Respectively. If the archaeological report, where required, indicates that an archaeological resource may be present, the lessee must either locate the site of any operation so as not to adversely affect the area where the archaeological resource may be, demonstrate that an archaeological resource does not exist, or demonstrate that archaeological resources will not be adversely affected by operations. If the lessee discovers any archaeological resource while conducting approved operations, operations must be immediately stopped and the discovery reported to the BOEM Regional Supervisor, Office of Environment, within 48 hours of its discovery.

Tables 3-2, 3-3, 3-4, 3-5, and 3-6 show the estimated range of exploration and delineation wells by water-depth range for the WPA and CPA typical sale cases; WPA, CPA, and EPA total OCS Program case; and WPA and CPA cumulative cases, respectively.

WPA Proposed Action Scenario (Typical Sale): The BOEM estimates that 53-89 exploration and delineation wells would be drilled as a result of a WPA proposed action. **Table 3-2** shows the estimated range of exploration and delineation wells by water-depth range. Approximately 56-57 percent of the projected wells are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and 43-44 percent are expected in the intermediate water-depth ranges and deeper (>200 m; 656 ft).

CPA Proposed Action Scenario (Typical Sale): The BOEM estimates that 168-329 exploration and delineation wells would be drilled as a result of a CPA proposed action. **Table 3-3** shows the estimated range of exploration and delineation wells by water-depth range. Approximately 51 percent of the projected wells for a CPA proposed action are expected to be on the continental shelf (0-200 m [0-656 ft] water depth), and about 49 percent are expected in intermediate water-depth ranges and deeper (>200 m; 656 ft).

OCS Program Cumulative Scenario (WPA, CPA, and EPA): The BOEM estimates that 6,910-9,827 exploration and delineation wells would be drilled in the WPA, CPA, and EPA as a result of all past OCS Program activity and forecasted activity associated with the 2012-2017 OCS Program. **Tables 3-4, 3-5, and 3-6** show the estimated range of exploration and delineation wells by water-depth range. Of these wells, 54 percent are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and 46 percent are expected in intermediate water-depth ranges and deeper (>200 m; 656 ft). The impact-producing factors, affected environment, and environmental consequences related to lease sales within the EPA will be disclosed and addressed in a subsequent Eastern Planning Area EIS within this 5-Year Program.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.3. Development and Production

3.1.1.3.1. Development and Production Drilling

Delineation and production wells are sometimes collectively termed development wells. A development well is designed to extract resource from a known hydrocarbon reservoir. After a discovery, the operator must decide whether or not to complete the well without delay, to delay completion with the rig on station so that additional tests may be conducted, or to temporarily abandon the well site and move the rig off station to a new location and drill another well. Sometimes an operator will decide to drill a series of development wells, move off location, and then return with a rig to complete all the wells at one time. If an exploration well is clearly a dry hole, the operator permanently abandons the well without delay.

When the decision is made to complete the well, a new stage of activity begins. Completing a well involves preparing the well for production. The BOEM estimates that 89-90 percent of development wells would become producing wells. The typical process includes setting and cementing the production casing, installing some downhole production equipment, perforating the casing and surrounding cement, treating the formation, setting a gravel pack (if needed), and installing production tubing. One form of formation treatment is known as "fracing." Fracing involves pressurizing the well to force chemicals or mechanical agents into the formation. Mechanical agents, such as sand or small microspheres (tiny glass beads), can be used to prop open the created factures that act as conduits to deliver hydrocarbons to the wellbore. Well treatment chemicals are commonly used to improve well productivity. For example, acidizing a reservoir to dissolve cementing agents and improve fluid flow is the most common well treatment in the GOM. After a production test determines the desired production rate to avoid damaging the reservoir, the well is ready to go online and produce.

Development wells may be drilled from movable structures, such as jack-up rigs, fixed bottom-supported structures, floating vertically-moored structures, floating production facilities, and drillships (either anchored or dynamically positioned drilling vessels). The spectrum of these production systems are shown in **Figure 3-3**.

The type of production structure installed at a site depends mainly on water depth, but the total facility lifecycle, the type and quantity of hydrocarbon production expected, the number of wells to be drilled, and the number of anticipated tie backs from other fields can also influence an operator's procurement decision. The number of wells per structure varies according to the type of production structure used, the prospect size, and the drilling/production strategy deployed for the drilling program and for resource conservation. Production systems can be fixed, floating, or increasingly in deep water, subsea. Advances in the composition of drilling fluids and drilling technology are likely to provide operators with the means to reduce rig costs in the deepwater OCS program.

Until recently, there had been a gradual increase of drilling depth (as measured in true vertical depth [TVD]). Beginning in 1996, the maximum drilling depth increased rapidly, reaching depths below 9,144 m (30,000 ft) in 2002. In 2005, the Transocean *Discoverer Spirit* (Green Canyon Block 512) drilled, reaching a TVD of 10,411 (34,157 ft). The recent dramatic increase in TVD may be attributed to several factors, including enhanced rig capabilities, deeper exploration targets, royalty relief for shallow water, deep gas prospects, and the general trend toward greater water depths.

The BOEM has described and characterized production structures in its deepwater reference document (Regg et al., 2000). These descriptions are summarized in **Chapter 3.1.1.3.3.2**, "Offshore Production Systems" and were used in preparing the scenario for this EIS. In water depths of up to 400 m (1,312 ft), the scenarios assume that conventional, fixed platforms that are rigidly attached to the seafloor will be the type of structure preferred by operators. In water depths of <200 m (656 ft), 20 percent of the platforms are expected to be manned (defined as having sleeping quarters on the structure). In depths between 200 and 400 m (656 and 1,312 ft), all structures are assumed to be manned. It is also assumed that helipads will be located on 66 percent of the structures in water depths <60 m (197 ft), on 94 percent of structures in water depths between 60 and 200 m (656 ft), and on 100 percent of the structures in water depths >200 m (656 ft). At water depths >400 m (1,312 ft), platform designs based on rigid attachment to the seafloor are not expected to be used. The 400-m (1,312-ft) isobath appears to be the current economic limit for this type of structure.

A Deepwater Operations Plan (DWOP) is required for all deepwater development projects in water depths ≥1,000 ft (305 m) and for all projects proposing subsea production technology. A DWOP is designed to address industry and BOEM concerns by allowing an operator to know, well in advance of significant spending, that their proposed methods of dealing with situations not specifically addressed in the regulations are acceptable to BOEM. The DWOP provides BOEM with information specific to deepwater/subsea equipment issues to demonstrate that a deepwater project is being developed in an acceptable manner with regard to engineering specifics, safety, and the environment. The BOEM will review deepwater development activities from a total system perspective, emphasizing the operational safety, environmental protection, and conservation of natural resources. A DWOP is required initially and is usually followed by a DOCD.

Development Operations and Coordination Document

The chief planning document that lays out an operator's specific intentions for development is the DOCD. The range of postlease development plans is discussed in **Chapter 1.5**. **Table 3-2** shows the estimated range of development wells and production structures by water depth subarea for the WPA proposed action. The BOEM estimates that 87-89 percent of development wells would become producing wells.

WPA Proposed Action Scenario (Typical Sale): The BOEM estimates that 77-121 development and production wells would be drilled as a result of a WPA proposed action. **Table 3-2** shows the estimated range of development and production wells by water-depth subarea. Approximately 53-55 percent of the projected wells are expected to be on the continental shelf (0-200 m [656 ft] water depth) and 45-47 percent are expected in intermediate water-depth ranges and deeper (>200 m; 656 ft). Trends between the oil and gas development wells are markedly different. For oil wells (27-40), the intermediate water-depth ranges and deeper (200 m; 1,600 m) has the largest portion of projected oil wells, 55-60 percent. The percent of oil wells in the other water-depth categories ranges from 7 to 15 percent. For gas wells (36-62), the continental shelf (0-200 m [0-656 ft] water depth) has the largest portion of projected gas wells, about 80-81 percent. The percent of gas wells in the other water-depth categories is much less and ranges from 3 to 6 percent.

CPA Proposed Action Scenario (Typical Sale): It is estimated that 215-417 development and production wells will be drilled as a result of a CPA proposed action. **Table 3-3** shows the estimated range of development and production wells by water-depth subarea. The percentage of projected oil wells within the CPA is more evenly distributed throughout the water-depth ranges, with the greatest number of wells being forecasted for water depths >2,400 m (7,874 ft), whereas 66-75 percent of the gas wells are projected to be drilled on the continental shelf (0-200 m [0-656 ft] water depth).

OCS Program Cumulative Scenario (WPA, CPA, and EPA): It is estimated that 8,530-12,180 development and production wells will be drilled in the WPA, CPA, and EPA as a result of the proposed lease sales and all OCS activity associated with previous lease sales. **Tables 3-4, 3-5, and 3-6** show the estimated range of development wells by water depth.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.3.2. Infrastructure Emplacement/Structure Installation and Commissioning Activities

Bottom-founded or floating structures may be placed over development wells to facilitate production from a prospect. These structures provide the means to access and control the wells. They serve as a staging area to process and treat produced hydrocarbons from the wells, initiate export of the produced hydrocarbons, conduct additional drilling or reservoir stimulation, conduct workover activities, and carry out eventual abandonment procedures. There is a range of offshore infrastructure installed for hydrocarbon production. Among these are pipelines, fixed and floating platforms, caissons, well protectors, casing, wellheads, and conductors.

Subsea wells may also be completed to produce hydrocarbons from on the shelf and in the deepwater portions of the GOM. The subsea completions require a host structure to control their flow and to process their well stream. Control of the subsea well is accomplished via an umbilical from the host.

Pipelines are the primary means of transporting produced hydrocarbons from offshore oil and gas fields to distribution centers or onshore processing points. Pipelines range from small-diameter (generally 4-12 in; 10-30 cm) gathering lines, sometimes called flowlines, that link individual wells and production facilities to large-diameter (as large as 36 in; 91 cm) lines, sometimes called trunklines, for transport to shore. Pipelines are installed by lay barges that are either anchored or dynamically-positioned while the pipeline is laid. Pipeline sections may be welded together on a conventional lay barge as it moves forward on its route or they may be welded together at a fabrication site onshore and wound onto a large-diameter spool or reel. Once the reel barge is on location, the pipeline is straightened and lowered to the seafloor on its intended route. Both types of lay barge use a stinger to support the pipeline as it enters the water. The stinger helps to prevent undesirable bending or kinking of the pipeline as it is installed. In some cases, pipelines or segments of pipelines are welded together onshore or along a beach front area and then towed offshore to their location for installation.

Fixed, jacketed platforms are the most common surface structures of the GOM and account for about 60 percent of all bottom-founded surface structures on the shallow continental shelf. Fixed platforms are brought on location as a complete unit or in sections on an installation barge towed by powerful tug boats. If the structure is fabricated in sections, it is generally composed of two segments called the jacket (the lower portion) and the deck (the portion above the water line). Accidents have occurred during the vulnerable period when heavy equipment is held only by cranes. In December 1998, the 3,600-ton topside structure for the Petronius compliant tower was lost in 533 m (1,750 ft) of water as it was being lifted into place by the lift barge in Viosca Knoll Block 892.

The platform's tubular-steel jacket is then launched from the barge, upended, and lowered into position by a derrick barge with a large crane. The jacket is anchored to the seafloor by piles driven through the legs. The deck section with one or more levels is then lifted atop the jacket and welded to the foundation. The platform may have a helipad installed on its deck section. Platforms may or may not be manned continuously. The different types of floating platforms are discussed in **Chapters 3.1.1.3.1 and 3.1.1.3.3.2.**

Caissons are the second most numerous and account for about 30 percent of bottom-founded, surface structures in the GOM. Caissons are located primarily on the shallow continental shelf. Simpler in design and fabrication than traditional jacketed platforms, most caissons consist of a steel pipe that generally ranges from 36 to 96 in (91 to 2.44 cm) in diameter. The caisson pipe is driven over existing well(s) to a depth that allows for shoring against varying sea states. Though primarily installed for well protection, some caissons may also be used as foundations for equipment and termination or relay points for pipeline operations.

Well protectors account for about 10 percent of all bottom-founded surface structures in the GOM. Well protectors are used primarily to safeguard producing wells and their production trees from boat damage and from battering by floating debris and storms. Similar to fixed platforms, well protectors consist of small piled jackets with three or four legs generally less than 36 in (91 cm) in diameter, which may or may not support a deck section.

Structure installation and commissioning activities may take place over a period of a week to a month at the beginning of a platform's 20- to 40-year production life. The time required to complete the myriad of operations to start production at a structure is dependent on the complexity of its facilities.

To keep floating structures on station, a mooring system must be designed and installed. Lines to anchors or piling arrays attach the floating components of the structure. With a TLP, tendons stem from a base plate on the sea bottom to the floating portion of the structure. Commissioning activities involve the emplacement, connecting, and testing of the structure's modular components that are assembled on site.

WPA Proposed Action Scenario (Typical Sale): It is estimated that 15-23 production structures will be installed as a result of a WPA proposed action. **Table 3-2** shows the projected number of structure installations for a WPA proposed action by water-depth range. About 67-74 percent of the production structures installed for a proposed action in the WPA are projected to be on the continental shelf (0-60 m; 0-197 ft).

CPA Proposed Action Scenario (Typical Sale): It is estimated that 35-67 production structures will be installed as a result of a CPA proposed action. **Table 3-3** shows the projected number of structure installations for a CPA proposed action by water-depth range. About 80-81 percent of all the production structures installed for a proposed action in the CPA are projected to be on the continental shelf (0-60 m; 0-197 ft).

OCS Program Cumulative Scenario (WPA, CPA, and EPA): It is estimated that 1,435-2,026 production structures would be installed in the WPA, CPA, and EPA as a result of the proposed lease sales and all OCS activity associated with previous lease sales. About 92-93 percent of all the production structures installed for a CPA proposed action in are projected to be on the continental shelf (0-200 m; 0-656 ft). **Tables 3-4, 3-5, and 3-6** show the projected number of structure installations by water-depth range for the OCS Program.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.3.2.1. Bottom Area Disturbance

Structures emplaced or anchored on the OCS to facilitate oil and gas exploration and production include drilling rigs or MODU's (jack-ups, semisubmersibles, and drillships), pipelines, and fixed surface, floating, and subsea production systems are described in **Chapters 3.1.1.3.1 and 3.1.1.3.2** above. The emplacement or removal of these structures disturbs small areas of the sea bottom beneath or adjacent to the structure. If mooring lines of steel, chain, or synthetic polymer are anchored to the sea bottom, areas around the structure can also be directly affected by their emplacement. This disturbance includes physical compaction or crushing beneath the structure or mooring lines and the resuspension and settlement of sediment caused by the activities of emplacement. Movement of floating types of facilities will also cause the movement of the mooring lines in its array. Small areas of the sea bottom will be affected by this kind of movement. Impacts from bottom disturbance are of concern near sensitive areas such as topographic features, pinnacles, low-relief live-bottom features, chemosynthetic communities, high-density biological communities in water depths ≥400 m (1,312 ft), and archaeological sites.

Jack-up rigs are used in shallow water and disturb approximately 1 ha (2.5 ac) for each set up. Semisubmersibles can be operated in a wide range of water depths and disturb about 2-3 ha (5-7 ac), depending on their mooring configurations. In water depths >600 m (1,969 ft), dynamically positioned (drillships could be used; these drillships disturb only a very small area where the bottom template and wellbore are located, approximately 0.25 ha (0.62 ac). Since the advent of synthetic mooring lines, some drillships may be moored to the bottom. Drillships would affect an area of the bottom similar to that of the semisubmersibles, depending on their mooring array at their water depth.

Conventional, fixed platforms installed in water depths less than about 400 m (1,312 ft) disturb about 2 ha (5 ac) of the sea bottom. At water depths exceeding 400 m (1,312 ft), compliant towers, tension-leg platforms (TLP's), spars, and floating production systems (FPS's) would be used (**Figure 3-3)**. A compliant tower would disturb the same bottom area—about 2 ha (5 ac)—as a conventional, fixed platform. A TLP consists of a floating structure held in place by tensioned tendons connected to the seafloor by pile-driven anchors. The bottom area disturbed by a TLP is dependent on the mooring line configuration and would be about 0.5 ha (1.2 ac) per anchor. A spar platform consists of a large-diameter cylinder supporting a conventional deck, three types of risers (production, drilling, and export), and a hull that is moored by a catenary system of 6-20 lines anchored to the seafloor. A spar would disturb about 1 ha (2.5 ac) of bottom area per mooring line, because mooring lines tend to be anchored farther away from the surface structure, which tends to cause more contact and scraping of the sea bottom near the anchor. Where applicable, a taut leg mooring system may be employed. This type of system exerts more tension on the mooring lines and results in fewer impacts to the seafloor.

A FPS or floating production, storage, and offloading (FPSO) might be deployed in an area not serviced by pipelines. These systems consist of a semisubmersible or vessel anchored in place with mooring lines and that may be integrated with a floating storage system for produced oil. An FPS would disturb approximately 2-3 ha (5-7 ac) of sea bottom, depending on the number of wells produced, the number of mooring lines, and whether or not the system is anchored at all or is dynamically positioned.

Subsea production systems located on the ocean floor are connected to surface topsides by a variety of components. These bottom-founded components are an integrated system of flowlines, manifolds, flowline termination sleds, umbilicals, umbilical sleds, blowout preventers, well trees, and production risers that disturb approximately 1 ha (2.5 ac) of sea bottom per well produced.

Emplacement of flowlines and export pipelines disturb between 0.5 ha (1.2 ac) and 1.0 ha (2.5 ac) of seafloor per kilometer of pipeline (Cranswick, 2001). The variation lies in the BSEE requirement to bury pipelines in water depths <200 ft (61 m) to a depth of 3 ft (1 m). Burial is typically done by water jetting a trench followed by placing the pipeline into it. Approximately 30-34 percent of the new pipeline length installed as a result of a WPA and CPA proposed action (typical sales) and the OCS Program cumulative scenario (all OCS activity associated with WPA, CPA, and EPA proposed and past lease sales) would be in water depths <200 ft (61 m) requiring burial.

3.1.1.3.2.2. Sediment Displacement

Displaced sediments are those that have been physically moved "in bulk." Displaced sediments will cover or bury an area of the seafloor, while resuspended sediments will cause an increase in turbidity of the adjacent water column. Resuspended sediments eventually settle, covering the surrounding seafloor. Resuspended sediments may include entrained heavy metals or hydrocarbons.

The chief means for sediment displacement is the overboard discharge of drill cuttings carried to the surface and by drilling mud. Cuttings that outfall from surface platforms settle to the sea bottom as a mound or plume if influenced by the prevailing currents. Sediment displacement can also take place when anchored exploration rigs and production structures are subject to high current energy, such as GOM loop currents or hurricane sea states. Mooring lines in contact with the sea bottom can scrape sediment into heaps and mounds as the surface facility moves in response to currents.

Trenching for pipeline burial causes displacement or resuspension of seafloor sediments. Sediment displacement also occurs as a result of the removal of pipelines. It is projected that the number of pipeline removals (or relocations) will increase Gulfwide as the existing pipeline infrastructure ages. For each kilometer of pipeline removed in water depths <200 ft (61 m), approximately 5,000 m^3 (176,573 ft^3)of sediment would be displaced and resuspended.

3.1.1.3.3. Infrastructure Presence

3.1.1.3.3.1. Anchoring

Most exploration drilling, platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, topside structures, or support vessels in place. Anchors disturb the seafloor and sediments in the area where dropped or emplaced. Anchoring can cause physical compaction beneath the anchor and chains or lines, as well as resuspended sediment. A disturbed area on the sea bottom forms by the swing arc formed by anchor lines scraping across bottom within the range allowed by the anchoring system configuration. Dynamically positioned rigs, production structures, and vessels are held in position by four or more propeller jets and do not cause anchoring impacts. Conventional pipelaying barges use an array of eight 9,000-kg (19,842-lb) anchors to position the barge and to move it forward along the pipeline route. These anchors are continually moved as the pipelaying operation proceeds. The area actually affected by these anchors depends on water depth, wind, currents, chain length, and the size of the anchor and chain. Mooring buoys may be placed near drilling rigs or platforms so that service vessels need not anchor or for when they cannot anchor (in deeper water). The temporarily installed anchors for these buoys will most likely be smaller and lighter than those used for vessel anchoring and, thus, will have less impact on the sea bottom. Moreover, installing one buoy will preclude the need for numerous individual vessel-anchoring occasions. Service vessel anchoring is assumed not to occur in water depths >150 m (492 ft) and only occasionally in shallower waters (vessels would always tie up to a platform or buoy in water depths >150 m [492 ft]). Barges are assumed to always tie up to a production system rather than anchor. Barges and other vessels are also used for both installing and removing structures. Barge vessels use anchors placed away from their location of work.

3.1.1.3.3.2. Offshore Production Systems

Spar

A spar structure is a deep-draft, floating caisson that may consist of a large-diameter (27.4-36.6 m; 90-120 ft) cylinder or a cylinder with a lower tubular steel trellis-type component (truss spar, a second generation design) that supports a conventional production deck. A third generation of spar design is the cell spar. The cell spar's hull is composed of several identically sized cylinders surrounding a center cylinder. The cylinder or hull may be moored via a chain catenary or semi-taut line system connected to 6-20 anchors on the seafloor. Spars are now used in water depths up to 900 m (2,953 ft) and may be used in water depths 3,000 m (9,843 ft) or deeper (NaturalGas.org, 2010; USDOI, MMS, 2006a; Oynes, 2006).

Semisubmersibles

Semisubmersible production structures (semisubmersibles) resemble their drilling rig counterparts and are the most common type of offshore drilling rig (NaturalGas.org, 2010a). Semisubmersibles are partially submerged with pontoons that provide buoyancy. Their hull contains pontoons below the waterline and vertical columns that connect to the hull box/deck. The structures keep on station with conventional, catenary or semi-taut, line mooring systems connected to anchors in the seabed. Semisubmersibles can be operated in a wide range of water depths. Floating production systems are suited for deepwater production in depths up to 8,000 ft (26,437 m) (NaturalGas.org, 2010; USDOI, MMS, 2006a; Oynes, 2006).

Subsea Production Systems

For some development programs, especially those in deep- and ultra-deepwater, an operator may choose to use a subsea production system instead of a floating production structure. Although the use of subsea systems has recently increased as development has moved into deeper water, subsea systems are not new to the GOM and they are not used exclusively for deepwater development. Unlike wells from conventional fixed structures, subsea wells do not have surface facilities directly supporting them during their production phases. A subsea production system has various bottom-founded components. Among them are well templates, well heads, "jumper" connections between well heads, flow control manifolds, in-field pipelines and their termination sleds, and umbilicals and their termination assemblies. A subsea production system can range from a single-well template connected to a nearby manifold or pipeline, and then to a riser system at a distant production facility; or a series of wells that are tied into the system. Subsea systems rely on a "host" facility for support and well control. Centralized or "host" production facilities in deep water or on the shelf may support several satellite subsea developments. A drilling rig must be brought on location to provide surface support to reenter a well for workovers and other types of well maintenance activities. In addition, should the production/safety system fail and a blowout result, surface support must be brought on location to regain control of the well.

Floating Production, Storage, and Offloading Systems

This Agency prepared an EIS on the potential use of floating production, storage, and offloading (FPSO) systems on the Gulf of Mexico OCS (USDOI, MMS, 2001). In accordance with the scenario provided by industry, the floating production, storage, and offloading EIS addresses the proposed use of FPSO's in the deepwater areas of the CPA and WPA only. In January 2002, this Agency announced its decision to accept applications for FPSO's after a rigorous environmental and safety review. On June 12, 2007, this Agency received a DOCD from Petrobras Americas Inc. proposing to use an FPSO in Walker Ridge to develop two different CPA prospects: Cascade and Chinook. This is the first and only proposal, at this time, to use an FPSO in the GOM. The Cascade Prospect (Walker Ridge Block 206 Unit) is located approximately 250 mi (402 km) south of New Orleans, Louisiana, and about 150 mi (241 km) from the Louisiana coastline in approximately 8,200 ft (2,499 m) of water. The Chinook Prospect (Walker Ridge Block 425 Unit) is located about 16 mi (26 km) south of the Cascade Prospect. The FPSO was approved in March 2011.

3.1.1.3.3.3. Space-Use Requirements

Leasing on the OCS results in operations that temporarily occupy sea bottom and water surface area for dedicated uses. The OCS operations include the deployment of seismic vessels, bottom surveys, and the installation of surface or subsurface bottom-founded production structures with anchor cables and safety zones. While in use, these areas become unavailable to commercial fishermen or any other competing use.

Seismic surveys will occur in both shallow and deepwater areas of the proposed actions. Usually, fishermen are precluded from a very small area for several days during active seismic surveying. Exploratory drilling rigs spend approximately 40-150 days onsite and are a short-term interference to commercial fishing. A major bottom-founded production platform in water depths less than 450 m (1,476 ft), with a surrounding 100-m (328-ft) navigational safety zone, requires approximately 6 ha (15 ac) of space. A bunkhouse structure requires about 4 ha (9 ac) and a satellite structure requires about 1.5 ha (3.7 ac) of space. Virtually all commercial trawl fishing in the GOM is performed in water depths less than 200 m (656 ft) (Louisiana Dept. of Wildlife and Fisheries, 1992). A total of 31.2 million ha (77 million ac) in the WPA and CPA are located in water depths of 200 m (656 ft) or less.

Longline fishing is performed in water depths greater than 100 m (328 ft) and usually beyond 300 m (984 ft). All surface longlining is prohibited in the northern De Soto Canyon area (designated as a swordfish nursery area by NMFS). The longline closure area encompasses at least some part of 539 blocks in the CPA. Longline fishing will also probably be effectively precluded from blocks for miles around the closure area because of the great length of typical longline sets and time required for their retrieval.

In water depths greater than 450 m (1,476 ft), production platforms will be compliant towers or floating structures (such as TLP's and spars); this is beyond the range of typical commercial bottom trawling. Even though production structures in deeper water are larger and individually will take up more space, there will be fewer of them compared to the great numbers of bottom-founded platforms in shallower water depths. The use of tanker-based FPSO's is also being considered by operators in the Gulf and up to three are projected to be used in both the WPA and CPA proposed actions in water depths >800 m (2,625 ft). The USCG has not yet determined what size navigational safety zone will be required during offloading operations. Factoring in various configurations of navigational safety zones, other deepwater facilities may require up to a 500-m (1,640-ft) radius safety zone or 78 ha (193 ac) of space (USCG regulations, 33 CFR Chapter 1, Part 147.15). Production structures in all water depths have a life expectancy of 20-30 years. The BOEM data indicate that the total area lost to commercial fishing due to the presence of production platforms has historically been and will continue to be less than 1 percent of the total area available.

Coastal restoration, beach nourishment, and levee reconstruction are crucial to mitigate future coastal erosion, landloss, flooding, and storm damage in the GOM, especially along coastal Louisiana. The success of that long-term effort depends on locating and securing significant quantities of OCS sediment resources that are compatible with the target environments being restored. Offshore sand resources, like upland sources, are extremely scarce where most needed. Additionally, sizable areas of these relatively small offshore sand resources are not extractable because of the presence of oil and gas infrastructure, archaeologically sensitive areas, and biologically sensitive areas.

The BOEM has identified significant sediment resources where dredging activities are likely to occur in the future. Additionally, BOEM has implemented new measures to help safeguard the most significant OCS sediment resources, reduce multiple-use conflicts, and minimize interference with oil and gas operations. Bottom-disturbing activities (including surface or near-surface emplacement of platforms, wells, drilling rigs, pipelines, umbilicals, and cables) must avoid, to the maximum extent practicable, significant OCS sediment resources.

Dredging of sand and the associated presence of an ocean-going dredge vessel could present some use conflicts with commercial fishing should the blocks be occupied by dredging barges and associated transport infrastructure.

WPA Proposed Action Scenario (Typical Sale): A maximum of 138 ha (345 ac) (23 production structures of approximately 6 ha [15 ac]) of surface area will be lost to commercial fishing and other uses as a result of a WPA proposed action.

CPA Proposed Action Scenario (Typical Sale): A maximum of 402 ha (1005 ac) (67 production structures of approximately 6 ha [15 ac]) of surface area will be lost to commercial fishing and other uses as a result of a CPA proposed action.

The net effect on total area available for commercial trawling and other uses will also be affected by structure removals. Structures removed in water depths <200 m (656 ft) in most cases would be taken to shore, resulting in trawl area being opened up. Approximately 10 percent of eligible structures removed are eventually used for rigs-to-reef. Those structures that may become artificial reef would open space where removed and take space where reefed. Even when platforms are transported to designated artificial reef planning areas, which already effectively prevent trawling, the net effect would again be additional trawling area. If platform removals are set against those installed, the effective net area taken for temporary OCS use because of additional platforms is one platform added to the WPA representing a net area taken of 6 ha (15 ac) and six platforms added to the CPA, representing a net area taken of 36 ha (540 ac).

OCS Program Cumulative Scenario (WPA, CPA, and EPA): The total number of production structure installations projected for the OCS Program is 1,435-2,026 for all depth ranges. If platform removals are set against those installed, the effective net area taken for temporary OCS use because of additional platforms is a maximum of 189 platforms added to OCS waters representing a net area taken of 1,134 ha (2,835 ac).

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.3.3.4. Aesthetic Quality

The presence of drilling and production platforms visible from land, increased vessel and air traffic, and noise are aesthetic impacts associated with the proposed action and routine events. The aesthetics for industrialized infrastructure is a subjective judgment, but it is usually regarded as a negative aesthetic if facilities of this type are visible. Visibility of industrial structures on an open horizon that may be frequented by people precisely for the open horizon is a net negative aesthetic and a conflict in space use. The potential visibility of fixed structures in local GOM waters could be of concern to business operators, local chambers of commerce, and organizations promoting tourism. Installed facilities and increased vessel and air traffic add a component of additional noise as well as their physical presence on the seascape.

In a study conducted by the Geological Survey of Alabama in 1998, several facets of the visibility of offshore structures were analyzed. The Geological Survey of Alabama earth scientists found that visibility is dictated not only by size and location of the structures and curvature of the Earth but also by atmospheric conditions. Social scientists added factors, such as the viewer's elevation (ground level, in a 2-story house, or in a 30-story condominium) and the viewer's expectations and perceptions. The size of an offshore structure depends on the reservoir being tapped, characteristics of the well-stream fluid, and the type of processing needed to treat the hydrocarbons. Location reflects the geology of the reservoir. Optimal location of structures means at or near the surface above the reservoir (Geological Survey of Alabama, 1998). Atmosphere refers to conditions of weather, air quality, and the presence or absence of fog, rain, smog, and/or winds. The height of the viewer affects their ability to see and distinguish objects several miles away. Perceptions often dictate what people expect to see and, hence, what they do see.

To scientifically test visibility, Geological Survey of Alabama staff worked with members of the Offshore Operators Committee. They took a series of photographs on one day in October 1997, from a helicopter hovering at 300 ft (91 m). They used the same camera, lens, shutter speed, and f-stop setting. The subjects of the photos were four different types of structures usually found in both State and Federal waters offshore Alabama. The structures ranged in height from 60 to 70 ft (18 to 21 m); they varied in size from 120 ft by 205 ft (37 m by 62 m) to 40 ft by 90 ft (12 m by 27 m), with the smallest being 50 ft by 80 ft (15 m by 24 m). The tallest and widest structures, i.e., those showing the most surface in the viewscape, were visible at up to 5 mi (8 km) from shore. The shorter and the smaller the structure, the less visible at 5 mi (8 km); the smallest could barely be seen at 3 mi (5 km) from shore. According to this study, no structure located more than 10 mi (16 km) offshore would be visible (Geological Survey of Alabama, 1998).

The natural curvature of the Earth renders a 60-ft (18-m) tall ship invisible to a person at sea level when >12 mi (19 km) from shore. The formula for the distance to the horizon is given as your eye height above sea level, plus the height of the object under view, then square root of that sum, multiplied by 1.5. Rasmussen (2008) includes a calculator. A structure 250 ft (76 m) above sea level, such as an oil platform, would not be visible to 6-ft-tall beach goers if it is >24 mi (38 km) from shore. The WPA is 9 nmi (10 mi; 16 km) from the Texas shore and only under good weather conditions would a platform be visible to a person standing at the shoreline, or to a person in a multi-story building.

The WPA is 10.4 mi (16.7 km) from Texas; therefore, no structures located in the WPA would be visible from shore. The CPA is 3 nmi (3.5 mi; 5.6 km) from Louisiana, Mississippi, and Alabama. In the CPA, there are nearly 1,000 platforms (34% of structures in < 60 m [197 ft]) within 10 mi (16 km) of the coast.

WPA Proposed Action Scenario (Typical Sale): Because of the distance to shore, no structures installed in the WPA would be visible from shore at sea level under ordinary circumstances. Structures installed in the extreme western Louisiana OCS, just outside of the 3-nmi (3.5-mi; 5.6-km) boundary, may be visible from shore in Texas.

CPA Proposed Action Scenario (Typical Sale): Of the structures projected to be installed in water 0-60 m (0-197 ft) deep as a result of a CPA proposed action (**Table 3-3**), 4-7 would be located within 10 mi (16 km) of the coast and would be visible from the shore at sea level.

OCS Program Cumulative Scenario: Because of the distance to shore, no OCS structures in the WPA are now, or ever will be, visible from shore at sea level, while they operate. Of the structures projected to be installed in 0-60 m (0-197 ft) as a result of the OCS Program in the CPA (**Table 3-6**), 124-174 (13%) would be located within 10 mi (16 km) from shore.

Note that offshore and onshore impact producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

Additional impact-producing factors associated with offshore oil and gas activities are oil spills and trash and debris. These are the most widely recognized as major threats to the aesthetics of coastal lands, especially recreational beaches. These factors, individually or collectively, may adversely affect the fishing industry, resort use, and the number and value of recreational beach visits. The effects of an oil spill on the aesthetics of the coastline depend on factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods (if any).

3.1.1.3.3.5. Workovers and Abandonments

Completed and producing wells may require periodic reentry that is designed to maintain or restore a desired flow rate. These procedures are referred to as a well "workover." Workover operations are also carried out to evaluate or reevaluate a geologic formation or reservoir (including recompletion to another strata) or to permanently abandon a part or all of a well. Examples of workover operations are acidizing the perforated interval in the casing, plugging back, squeezing cement, milling out cement, jetting the well in with coiled tubing and nitrogen, and setting positive plugs to isolate hydrocarbon zones. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from 1 day to several months to complete depending on the complexity of the operations, with a median of 7 days. Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. On the basis of historical data, BOEM projects a producing well may expect to have seven workovers or other well activities during its lifetime.

There are two types of well abandonment operations—temporary and permanent. An operator may temporarily abandon a well to (1) allow detailed analyses or additional delineation wells while deciding if a discovery is economically viable, (2) save the wellbore for a future sidetrack to a new geologic bottom-hole location, or (3) wait on design or construction of special production equipment or facilities. The operator must meet specific requirements to temporarily abandon a well. Permanent abandonment operations are undertaken when a wellbore is of no further use to the operator (i.e., the well is a dry hole or the well's producible hydrocarbon resources have been depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well that contain hydrocarbons are plugged with cement. A cement surface plug is also required for the abandoned wells. This serves as the final isolation component between the wellbore and the environment.

3.1.1.4. Operational Waste Discharged Offshore

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, various waters (e.g., bilge, ballast, fire, and cooling), deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced water, produced sand, and well treatment, workover, and completion (TWC) fluids. Minor additional discharges occur from numerous sources. These discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, several fluids used in subsea production, and uncontaminated freshwater and saltwater.

The USEPA, through general permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities. The USEPA Region 4 has jurisdiction over the eastern portion of the Gulf of Mexico OCS, including all of the EPA and a portion of the CPA off the coasts of Alabama and Mississippi (**Figure 3-4**). The USEPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA.

Each USEPA Region has promulgated general permits for discharges that incorporate the 1993 effluent guidelines and 2001 effluent guidelines for SBF-wetted cuttings as a minimum. The current Region 4 general permit (GEG460000) was issued on March 15, 2010; became effective on April 1, 2010; and expires on March 31, 2015 (USEPA, 2011a). The current general permit is valid for 5 years.

3.1.1.4.1. Drilling Muds and Cuttings

Drilling fluids (also known as drilling muds) and cuttings represent a large quantity of the discharge generated by drilling operations. Drilling fluids are used in rotary drilling to remove cuttings from beneath the bit, to control well pressure, to cool and lubricate the drill string and its bit, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid. Drilling discharges of muds and cuttings are regulated by USEPA through an NPDES permit.

The composition of drilling fluids is complex. Drill cuttings are a different grain size and composition from the existing surface sediments. Drilling fluids used on the OCS are divided into two categories: water based and nonaqueous based, in which the continuous phase is not soluble in water. Clays, barite, and other chemicals are added to the base fluid, which can be freshwater or saltwater in water-based fluids (WBF's), mineral or diesel oil-based fluids (OBF's), or synthetic-based fluids (SBF's). Additional chemicals are added to improve the performance of the drilling fluid (Boehm et al., 2001).

The WBF's have been used for decades in drilling on the OCS. In the GOM, they are the most commonly used drilling fluids for exploration and production wells. The discharge of WBF and cuttings associated with WBF is allowed almost everywhere on the OCS under the general NPDES permits issued by USEPA Regions 4 and 6, as long as the discharge meets guidelines. Individual permits may also be obtained.

Discharge of WBF results in increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and trace metals. Occasionally, formation oil may be discharged with the cuttings, adding hydrocarbons to the discharge. In shallow environments, WBF are rapidly dispersed in the water column immediately after discharge and rapidly descend to the seafloor (Neff, 1987). In deep waters, fluids dispersed near the water surface would disperse over a wider area than fluids dispersed in shallow waters.

The early nonaqueous drilling fluids, termed oil-based drilling fluids (OBF), were occasionally used for directional drilling and in drill-bore sections where additional lubricity was needed. Crude, diesel, and mineral oil were used. Diesel OBF contains light aromatics such as benzene, toluene, and xylene, and mineral oil was advantageous over diesel because it was less toxic. Hydrocarbon concentration and impacts to benthic community diversity and abundance have been observed within 200 m (656 ft) of the drill site with diminishing impacts measured to a distance of 2,000 m (6,562 ft) (Neff, 1987). All OBF and associated cuttings must be transported to shore for recycling or disposal unless reinjected. All OBF are likely to be replaced by SBF in deepwater drilling because of the many advantageous features of SBF (Neff et al, 2000). They are now rarely used in deepwater drilling operations and only occasionally on the shelf.

The SBF are manufactured hydrocarbons. Since the SBF are not petroleum based, they do not contain the aromatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH) that contributed to OBF toxicity and persistence on the seafloor (International Association of Oil and Gas Producers, 2003). The SBF mud system also contains additives such as emulsifiers, clays, wetting agents, thinners, and barite. Since 1992, SBF have been increasingly used, especially in deep water, because they perform better than WBF and OBF. The SBF reduce drilling times and costs incurred from expensive drilling rigs. By 1999, about 75 percent of all wells drilled in waters deeper than 305 m (1,000 ft) were drilled with SBF in the GOM (CSA, 2004b). Although there are many types of SBF, esters, internal olefins, and linear alpha olefins are most commonly used in the GOM.

A literature review (Neff et al., 2000) discussed knowledge about the fate and effects of SBF discharges on the seabed. Like OBF, SBF are hydrophobic, do not disperse in the water column and therefore are not expected to adversely affect water quality. The SBF-wetted cuttings settle close to the discharge point and affect the local sediments. Cuttings piles with a maximum depth of 8-10 in (20-25 cm) were noted in a seabed study of shelf and slope locations where cuttings drilled with SBF were discharged. The primary effects are smothering of the benthic community, alteration of sediment grain size, and addition of organic matter, which can result in localized anoxia during the time it takes the SBF to degrade (Melton et al., 2004). Different formulations of SBF use base fluids that degrade at different rates, thus affecting the duration of the impact. Esters and olefins are the most rapidly biodegraded SBF.

Bioaccumulation tests indicate that SBF and their degradation products should not bioaccumulate (Neff et al., 2000). In a study to measure degradation rates of SBF on the seafloor and to characterize the microbial populations, the sulfate-reducing bacterial counts increased in sediments incubated with SBF under deep-sea conditions (Roberts and Nguyen, 2006). Biodegradation proceeded after a lag period of up to 28 weeks influenced by both the SBF type and prior exposure of the sediments to SBF. Sulfate depletion in the test sediments because of microbial activity coincided with SBF degradation. Incubation at atmospheric pressure or high pressure did not affect the rate of biodegradation. In the joint industry study required as part of the USEPA Region 6 NPDES permit, sediment recovery was noted during the 1-year interval between the first and second sample collection as indicated by a decrease in SBF concentrations. Deposited cuttings and measurable sediment effects indicative of organic enrichment were concentrated within 250 m (820 ft) distance in both shelf and slope sites (CSA, 2004b). The SBF concentrations in sediments at drill locations contained average internal olefin SBF concentrations of 500-13,000 parts per million (ppm) on the shelf and concentrations of 2,000 to 11,750 ppm on the slope, 1-4 years after discharge.

The discharge of the base SBF drilling fluid is prohibited. The SBF and the cuttings must meet environmental requirements. Both USEPA Regions permit the discharge of cuttings wetted with SBF as long as the retained SBF amount is below a prescribed percent, meets biodegradation and toxicity requirements, and is not contaminated with the formation oil or PAH. Ongoing research is aimed at understanding the relationships between chemical structure in SBF and environmental fates and effects, which will provide the design basis for fluids with better environmental performance. For example, recent testing showed that less branching of alpha and internal olefins positively impacted both sediment toxicity and anaerobic biodegradation (Dorn et al., 2011).

Typically, the upper portion of the well is drilled with WBF to a depth in the range of 800-2,000 m (2,625-6,562 ft) and, following "switchover," the remainder is drilled with SBF. The upper sections would be drilled with a large diameter bit; progressively smaller drill bits are used with increasing depth. Therefore, the volume of cuttings per interval (length of wellbore) in the upper section of the well would be greater than the volume generated in the deeper sections.

Barite, comprising barium sulfate, is used as a weighting agent and is a major component of all drilling fluid types. The amount of barite discharged from 81 wells during 1998 to 2002 was estimated because the quantity of barite used has declined with advances in SBM technology and drilling. The quantity of barite discharged for a shallow well (3,962 m; 13,000 ft) to a deep well (6,400 m; 21,000 ft) is 110 tons barite per well and 586 tons barite per well, respectively (Candler and Primeaux, 2003).

A comparative study of surface and subsurface sediment samples from six offshore drill locations showed higher levels of total mercury found in the sediments closest to the drilling sites as compared with the sites greater than 3 km (1.9 mi) distant. The higher total mercury concentrations corresponded to the higher barium concentrations also present. The higher total mercury levels in nearfield sediments did not translate to higher methylmercury concentration in those sediments, with a few exceptions (Trefry et al., 2002). Sediment redox conditions and organic content influence methylmercury formation.

Atmospheric mercury deposition is believed to be the main source of anthropogenic mercury inputs into the marine environment. However, mercury in fish tissue is a concern and mercury in barite has been suggested as a secondary source in the GOM. Mercury and other trace metals are naturally occurring impurities in barite. Since 1993, USEPA has required the 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 up drilling muds. Through mercury and cadmium regulation, USEPA can also control levels of other trace metals in barite. This reduces the addition of mercury to values similar to the concentration of mercury found in marine sediments throughout the GOM (Avanti Corporation, 1993a and 1993b; USEPA, 1993a and 1993b). Concentrations of total mercury in uncontaminated estuarine and marine sediments generally are 0.2 μg/g dry weight or lower. Surface sediments collected 20-2,000 m (66-6,562 ft) away from four oil production platforms in the northwestern GOM contained 0.044-0.12 μg/g total mercury. These amounts are essentially background concentrations for mercury in surficial sediments on the Gulf of Mexico OCS (Neff, 2002a).

Barite is nearly insoluble in seawater, thus trapping mercury and other trace metals in the barite grains. Therefore, unless the mercuric sulfide in the barite can be microbially methylated, this source of mercury is relatively unavailable for uptake into the marine food web. The solubility of barite and the rate at which it dissolves (and thereby releases associated metals such as mercury), the amount of metals released from the barite, and the rate of dissolution of barite and release of metals after burial under simulated seafloor conditions was studied (Crecelius et al., 2007). The research used three grades of barite: one commercially available barite ore used in drilling fluids, which meets USEPA acceptance criteria for trace metal content, and two grades of barite to represent those used in the GOM prior to the 1993 USEPA regulation enacted to reduce the concentrations of mercury (Hg) and cadmium (Cd) in drilling fluid. The solubility of the associated mercury in seawater at two pH concentrations tended to increase with time for at least several months, but remained well below the USEPA water quality criterion. The studies conducted at varying pH levels to mimic digestive tract conditions showed that very little (<0.1%) of the Hg in barite became biologically available.

In an extensive survey conducted by NMFS, seven species of reef fish were obtained at locations with extensive oil drilling, and thus barite, and were compared to reef fish obtained at locations with no drilling. No differences in mercury levels between the two groups were noted (Lowery and Garrett, 2005).

3.1.1.4.2. Produced Waters

Produced water is brought up from the hydrocarbon-bearing strata along with produced oil and gas. This waste stream can include formation water; injection water; well treatment, completion, and workover compounds added downhole; and compounds used during the oil and water separation process. Formation water, also called connate water or fossil water, originates in the permeable sedimentary rock strata and is brought up to the surface commingled with the oil and gas. Injection water is water that was injected to enhance oil production and in secondary oil recovery.

In addition to the added chemical products, produced water contains chemicals that have dissolved into the water from the geological formation where the water was stored. The amount of dissolved solids can be more concentrated than is found in seawater. Produced water contains inorganic and organic chemicals and radionuclides (226Ra and 228Ra). The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds.

Both USEPA general permits allow the discharge of produced water on the OCS provided they meet discharge criteria. The produced water is treated to separate free oil from the water. Since the oil and water separation process does not completely separate all of the oil, some hydrocarbons remain with the produced water and often the water is treated to prevent the formation of sheen. Produced water may be discharged if the oil and grease concentration does not exceed 42 milligrams per liter (mg/L) daily maximum or 29 mg/L monthly average. The discharge must also be tested for toxicity. Both USEPA permits require no discharge within 1,000 m (3,281 ft) of an area of biological concern. Region 4 also requires no discharge within 1,000 m (3,281 ft) of any federally designated dredged material ocean disposal site. Region 4 permits the discharge of a smaller range of produced water volumes than Region 6.

The Region 6 NPDES permit required the Produced Water Hypoxia Study, in which produced water was collected from 50 platforms that discharge into the hypoxic zone and was analyzed for oxygen-demanding characteristics (Veil et al., 2005; Rabalais, 2005). The mean biochemical oxygen demand (BOD) was 957 mg/L, total organic carbon (TOC) was 564 mg/L, and total Kjeldahl nitrogen (TKN) was 83 mg/L in produced waters from the platforms located within the hypoxic zone. Samples from platforms that produced mostly gas had higher average BOD and TOC concentrations but smaller volumes than platforms that produced mostly oil. About 508,000 bbl/day produced water was generated per day in the hypoxic zone in 2003. The estimated BOD loading is 104,000 lb/day. In comparison to loadings from the Mississippi and Atchafalaya Rivers, the total nitrogen loading from produced water is about 0.16 percent and total phosphorus loading is about 0.013 percent of the nutrient loading coming from the rivers.

Estimates of the volume of produced water generated per well vary because the percent water is related to well age and hydrocarbon type. Usually, produced-water volumes are small during the initial production phase and increase as the formation approaches hydrocarbon depletion. Produced water volumes range from 2 to 150,000 bbl/day (USEPA, 1993a and 1993b). In some cases, a centralized platform is used to process water from several surrounding platforms. Some of the produced water may be reinjected into the well. Reinjection occurs when the produced water does not meet discharge criteria or when the water is used as part of operations.

The BOEM maintains records of the volume of water produced from each block on the OCS and its disposition—injected on lease, injected off lease, transferred off lease, or discharged overboard. At present, the quantity discharged overboard is about 93-99 percent of the total volume of produced water extracted. The amount discharged overboard for the years 2000-2009 is summarized by water depth in **Table 3-7**. The total volume for all water depths during this 10-year period ranged from 489.0 to 648.2 million bbl (MMbbl), with the largest fraction (71-88%) coming from operations on the shelf. The total volume of produced water generally decreased during the 10-year period, reflecting an overall decrease in contributions from the shelf. The majority of blocks where water is produced are on the continental shelf off the coast of Louisiana. Very little water is produced off the coast of Texas because these are primarily gas fields.

The contribution of produced water from deep water (>400 m [1,312 ft] water depth) and ultra-deepwater (>1,600 m [5,249 ft] water depth) production has been steadily increasing. The contribution from these operations increased from 6 percent in 2000 to 25 percent in 2009 of the total produced water volume, contributing 37.8 and 129.6 MMbbl in each year, respectively (**Table 3-7**). The low temperature and high pressure conditions found in deeper water can result in flow problems such as hydrate formation in the lines. Additional quantities of chemicals are used to assure production, and even with recovery systems, some of these chemicals will be present in produced water (Regg et al., 2000). For deepwater operations, new technologies are being developed that may discharge or reinject produced water at the seafloor or at "minimal surface structures" before the production stream is transported by pipeline to the host production facility.

3.1.1.4.3. Well Treatment, Workover, and Completion Fluids

Wells are drilled using a base fluid and a combination of other chemicals to aid in the drilling process. Fluids (drilling muds) present in the borehole can damage the geologic formation in the producing zone. Completion fluids are used to displace the drilling fluid and protect formation permeability. "Clear" fluids consist of brines made from seawater mixed with calcium chloride, calcium bromide, and/or zinc bromide. These salts can be adjusted to increase or decrease the density of the brine to hold back-pressure on the formation. Additives, such as defoamers and corrosion inhibitors, are used to reduce problems associated with the completion fluids. Recovered completion fluids can be recycled for reuse.

Workover fluids are used to maintain or improve existing well conditions and production rates on wells that have been in production. Seven workovers are projected per producing well over their lifetime. Workover operations include casing and subsurface equipment repairs, re-perforation, acidizing, and fracturing stimulation. During some of the workover operations, the producing formation may be exposed, in which case fluids like the aforementioned completion fluids are used. In other cases, such as acidizing and fracturing (also considered stimulation or well treatment), hydrochloric (HCl) and other acids are used. Both procedures are used to increase the permeability of the formation. The acids dissolve limestone, sandstone, and other deposits. Because of the corrosive nature of acids, particularly when hot, corrosion inhibitors are added. Since the fluids are altered with use, they are not recovered and recycled; however, these products may be mixed with the produced water.

Production treatment fluids are chemicals applied during the oil and gas extraction process. Production chemicals are used to dehydrate produced oil or treat the associated produced water for reuse or disposal. A wide variety of chemicals are used including corrosion and scale inhibitors, bactericides, paraffin solvents, demulsifiers, foamers, defoamers, and water treatment chemicals (Boehm et al., 2001). Some of the production chemicals mix with the production stream and are transported to shore with the product. Other chemicals mix with the produced water. Most produced water cannot be discharged without some chemical treatment. Even water that is reinjected downhole must be cleaned to protect equipment. The types and volumes of chemicals that are used changes during the life of the well. In the early stages, defoamers are used. In the later stages, when more water than oil is produced, demulsifiers and water-treatment chemicals are used more extensively.

Both USEPA Regions 4 and 6 prohibit the discharge of well-treatment, completion, and workover fluid with additives containing priority pollutants. Additives containing priority pollutants must be monitored. Some well treatment, workover, and completion chemicals are discharged with the drilling muds and cuttings or with the produced-water streams. These discharges must meet the general toxicity limits in the NPDES general permit. Discharge and monitoring records must be kept.

3.1.1.4.4. Production Solids and Equipment

As defined by USEPA in the discharge guidelines (58 FR 12454), produced sands are slurried particles, which surface from hydraulic fracturing, and the accumulated formation sands and other particles including scale, which is generated during production. This waste stream also includes sludges generated in the produced-water treatment system, such as tank bottoms from oil/water separators and solids removed in filtration. The guidelines do not permit the discharge of produced sand, which must be transported to shore and disposed of as nonhazardous oil-field waste according to State regulations. Estimates of total produced sand expected from a platform are from 0 to 35 bbl/day according to USEPA (1993a and 1993b). A variety of solid wastes are generated including construction/demolition debris, garbage, and industrial solid waste. No equipment or solid waste may be disposed of in marine waters.

3.1.1.4.5. Bilge, Ballast, and Fire Water

Bilge, ballast, and fire water all constitute minor discharges generated by offshore oil and gas production activities, which are allowed to be discharged to the ocean, as long as USEPA guidelines are followed. Uncontaminated bilge and ballast water are included in the miscellaneous discharges category of the USEPA general permit (e.g., USEPA, 2007a). Ballast water is untreated seawater that is taken on board a vessel to maintain stability. Ballast water contained in segregated ballast tanks never comes into contact with either cargo oil or fuel oil. Newly designed and constructed floating storage platforms use permanent ballast tanks that become contaminated with oil only in emergency situations when excess ballast must be taken on. Bilge water is seawater that becomes contaminated with oil and grease and with solids such as rust, when it collects at low points in the bilges. With the right equipment on board, dirty bilge and ballast water can be processed in a way that separates most of the oil from the water before it is discharged into the sea (USEPA, 1993a). The discharge of any oil or oily mixtures is prohibited under 33 CFR 151.10. The USEPA requires monitoring for visual sheen related to miscellaneous discharges, such as bilge and ballast water.

Offshore drilling rigs and the offshore production facilities used to process oil have special fire protection requirements. Fire water is defined as excess seawater or freshwater that permits the continuous operation of fire control pumps, as well as water released during training of personnel in fire protection (USEPA, 2007a). Fire control system test water is seawater, sometimes treated with a biocide that is used as test water for the fire control system on offshore platforms. This test water is discharged directly to the sea as a separate waste stream (USEPA, 1993a). As well, fire protection can also include a barrier of water that is sometimes used during flaring to provide protection between flaring systems and personnel, equipment, and facilities. The USEPA general permit allows for the discharge of fire water that meets their specified limitations. The requirements include regulations and monitoring for treatment chemicals, discharge rate, free oil, and toxicity.

3.1.1.4.6. Cooling Water

Cooling water is defined as water used for contact or noncontact cooling, including water used for equipment cooling, evaporative cooling tower makeup, and dilution of effluent heat content. Seawater is drawn through an intake structure on the drilling rig, ship, or platform to cool power generators and other machinery, and produced oil or water. A drillship can draw up to 35 million gallons of cooling water per day from a depth of 45-100 ft (14-30 m) below the water's surface. Organisms are killed through impingement or entrainment. When fish and other aquatic life become trapped against the screen at the entrance to the cooling water intake structure through the force of the water being drawn through the intake structure, it is termed impingement. Impingement causes mortality through physical injury and exhaustion. When eggs and larvae are sucked into the heat exchanger and eventually discharged from the facility, it is termed entrainment. The entrained organisms pass through the cooling system where they are exposed to pressure changes, thermal shock, and antifouling chemicals such as chlorine. At the population level, these impacts can affect threatened or endangered species or reduce ecologically critical organisms within the food web (*Federal Register*, 2006b).

The Clean Water Act, Section 316 (b) Phase III established categorical regulations for offshore oil and gas cooling water intake structures. The NPDES permit incorporated these regulations in NPDES General Permit GMG290000 for the USEPA Region 6 and General Permit GEG460000 for the USEPA Region 4 for new facilities, where construction began after July 17, 2006, and that take in more than 2 million gallons per day of seawater with more than 25 percent used for cooling (USEPA, 2007a). The new requirements have several tracks depending on whether the facility is a fixed or nonfixed facility and whether it has a sea chest intake or not. Some of the requirements include cooling water intake structure design requirements to meet a velocity of <0.5 ft (0.2 m) per second, construction to minimize impingement and/or entrainment, entrainment monitoring, recordkeeping, and completion of a source water biological study. Alteration to a sea chest intake structure on a mobile facility could render the facility less seaworthy, so is not required. The requirements include baseline study that characterizes the biological community in the vicinity of the structure or monitoring. For USEPA Region 6, the Offshore Operators Committee completed a Joint Industry Biological Baseline Study in June 2009 (LGL, 2009).

3.1.1.4.7. Deck Drainage

Deck drainage includes all wastewater resulting from platform washings, deck washings, rainwater, and runoff from curbs, gutters, and drains including drip pans and work areas. The USEPA general guidelines for deck drainage require that no free oil be discharged, as determined by visual sheen.

The quantities of deck drainage vary greatly depending on the size and location of the facility. An analysis of 950 GOM platforms during 1982-1983 determined that deck drainage averaged 50 bbl/day/platform (USEPA, 1993a and 1993b). The deck drainage is collected, the oil is separated, and the water is discharged to the sea. Impacts from the discharge of deck drainage are assumed to be negligible for a proposed action.

3.1.1.4.8. Treated Domestic and Sanitary Wastes

Domestic wastes originate from sinks, showers, laundries, and galleys. Sanitary wastes originate from toilets. For domestic waste, no solids or foam may be discharged. In addition, the discharge of all food waste within 12 nmi (14 mi; 22 km) from the nearest land is prohibited. In sanitary waste, floating solids are prohibited. Facilities with 10 or more people must meet the requirement of total residual chlorine greater than 1 mg/L and maintained as close to this concentration as possible. There is an exception in both general permits for the use of marine sanitation devices.

In general, a typical manned platform will discharge 35 gallons per person per day of treated sanitary wastes and 50-100 gallons per person per day of domestic wastes (USEPA, 1993a and 1993b). It is assumed that these discharges are rapidly diluted and dispersed; therefore, no analysis of the impacts will be performed for a proposed action.

3.1.1.4.9. Minor Discharges

Minor discharges include all other discharges not already discussed that may result during oil and gas operations. Minor or miscellaneous wastes include desalination unit discharge, blowout preventer fluid, boiler blowdown, excess cement slurry, uncontaminated freshwater and saltwater, and miscellaneous discharges at the seafloor, such as subsea wellhead preservation and production control fluid, umbilical steel tube storage fluid, leak tracer fluid, and riser tensioner fluids. In all cases, no free oil shall be discharged with the waste. Unmanned facilities may discharge uncontaminated water through an automatic purge system without monitoring for free oil. The discharge of freshwater or seawater that has been treated with chemicals is permitted providing that the prescribed discharge criteria are met. No projections of volumes or contaminant levels of minor discharges are made for a proposed action because the impacts are considered negligible.

3.1.1.4.10. Vessel Operational Wastes

The USCG defines an offshore service vessel (OSV) as a vessel propelled by machinery other than steam that is of more than 15 gross tons and less than 500 gross tons and that regularly carries goods, supplies, individuals in addition to the crew, or equipment in support of exploration, exploitation, or production of offshore mineral or energy resources (46 CFR 90.10-40). Operational waste generated from supply vessels that support oil and gas operations include bilge and ballast waters, trash and debris, and sanitary and domestic wastes.

Bilge water is water that collects in the lower part of a ship. The bilge water is often contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures is prohibited under 33 CFR 151.10; however, discharges may occur in waters >12 nmi from land (14 mi; 22 km) if the oil concentration is less than 100 ppm. Discharges may occur within 12 nmi of land (14 mi; 22 km) if the concentration is less than 15 ppm.

Ballast water is used to maintain stability of the vessel and may be pumped from coastal or marine waters. Generally, the ballast water is pumped into and out of separate compartments and is not usually contaminated with oil; however, the same discharge criteria apply as for bilge water (33 CFR 151.10).

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 increased the NPDES regulation 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, 2008a). The next Vessel General Permit will include numeric concentration-based ballast water limits, as required by a recent court settlement (Showstack, 2011).

The discharge of trash and debris is prohibited (33 CFR 151.51-77) unless it is passed through a comminutor and can pass through a 25-mm (1-in) mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

All vessels with toilet facilities must have a marine sanitation device (MSD) that complies with 40 CFR 140 and 33 CFR 149. Vessels complying with 33 CFR 159 are not subject to State and local MSD requirements. However, a State may prohibit the discharge of all sewage within any or all of its waters. Domestic waste consists of all types of wastes generated in the living spaces on board a ship including gray water that is generated from dishwasher, shower, laundry, bath, and washbasin drains. Gray water from vessels is not regulated in the GOM. Gray water should not be processed through the MSD, which is specifically designed to handle sewage.

3.1.1.4.11. Upcoming Waste and Discharge Issues

Distillation and reverse osmosis brine means the concentrated seawater (brine) produced as a byproduct of the processes used to generate freshwater from seawater. At present, rigs and platforms support individual desalinization units. The discharge from these units is included under Miscellaneous Discharges in the NPDES general permit for Offshore Oil and Gas. As the industry moves offshore, individual larger platforms will support more and more activity over a larger geographic area using subsea production technology. Desalinization may be performed from water supply vessels that are specially equipped for desalinization. Although the vessel rather than the platform will discharge the waste brine, it will have similar characteristics as when generated on the platform. The Vessel General

Permit may not apply depending on the location of the rig/vessel. The Vessel General Permit, geographically, only covers inland waters out to 3 mi (5 km). Secondly, the Vessel General Permit applies to vessels acting as a means of transportation. If the vessel is moored to a rig generating an amount of water that is greater than what it takes for the normal operation of a vessel, the Vessel General Permit would not apply to the brine production.

Discharges from Diverter Actuation and Flow Testing (30 CFR 250.433): The BOEM requires actuation of the diverter system and flow-testing of the vent lines. When the system is first tested, seawater is discharged. Seawater discharge is already included in the NPDES permit. Actuation of the diverter valves must be repeated weekly throughout drilling operations. This important safety requirement has the potential to cause the discharge of SBF to the GOM. Such a discharge would be a violation of the existing NPDES permit. During the weekly tests, BOEM prefers that a person be stationed at the valves to confirm valve actuation. The SBF does not need to be discharged to confirm valve actuation. Alternatively, design changes can be made so that the discharge of SBF is not necessary.

3.1.1.5 Air Emissions

In 1990, pursuant to Section 328 of the Clean Air Act Amendments and following consultation with the Commandant of the U.S. Coast Guard and the Secretary of the Interior, USEPA assumed air quality responsibility for the OCS waters east of 87.5° W. longitude, and this Agency retained NAAQS air quality jurisdiction for OCS operations west of 87.5° W. longitude in the GOM.

Air pollutants are emitted from the OCS emission sources that include any equipment that combusts a fuel, transports and/or transfers hydrocarbons, or results in accidental releases of petroleum hydrocarbons or chemicals, causing air emissions of pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere. Air pollutants are generated during exploration and production activities when fuels are combusted to run drilling equipment, power generators, and run engines. During production, fugitive emissions, including volatile organic compounds, escape from valves and flanges. The NAAQS criteria pollutants are generated along routes from shore bases to OCS leases by vessels transporting supplies and workers.

The NAAQS air pollutants are also released during both venting and flaring. A combustion flare or cold vent is a specially designed boom or stack used to dispose of hydrocarbon vapors or natural gas. Unlike cold vents, the hydrocarbons are ignited during flaring. Flares can be used routinely to control emissions as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the wellbore and to provide sufficient reservoir data for the operator to evaluate a reservoir and development options; they can also be used during emergency process upsets. The BSEE's regulations provide for some limited volume, short duration flaring, or venting of oil and natural gas upon approval by BSEE (2-14 days, typically). Through 30 CFR 250.1105, BSEE may allow operators to burn liquid hydrocarbons if they can demonstrate that transporting them to market or re-injecting them into the formation is not technically feasible or poses a significant risk of harm to the environment.

3.1.1.6 Noise

Noise associated with OCS oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and may be extended or transient. Offshore drilling and production involves various activities that produce a composite underwater noise field. The intensity level and frequency of the noise emissions are highly variable, both between and among the various industry sources. Noise from proposed OCS activities may affect resources near the activities. Whether a sound is or is not detected by marine organisms would depend both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause physical damage or death to an exposed animal; intense levels can damage hearing; and loud or novel sounds may induce disruptive behavior or other responses of lesser importance.

When the Marine Mammal Protection Act was enacted in 1972, the concept that underwater sounds of human origin could adversely affect marine mammals was not considered or recognized (Marine Mammal Commission, 2002). Concern on the effects of underwater noise on marine mammals and the increasing levels of manmade noise introduced into the world's oceans has since become a major environmental issue (Jasny, 1999). It is generally recognized that commercial shipping is a dominant component of the ambient, low-frequency background noise in modern world oceans (Gordon and Moscrop, 1996) and that OCS-related, service-vessel traffic would contribute to this. Another sound source more specific to OCS operations originates from seismic operations. Airguns produce an intense but highly localized sound energy and represent a noise source of acoustic concern. The MMS has completed a Programmatic EA on G&G permit activities in the GOM (USDOI, MMS, 2004). The Programmatic EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are hereby incorporated by reference.

Marine seismic surveys direct a low-frequency energy wave (generated by an airgun array) into the ocean floor and record the reflected energy waves' response and return arrival time. The pattern of reflected waves, recorded by a series of hydrophones embedded in cables (streamers) towed by the seismic vessel or ocean bottom cables or nodes placed on the ocean floor, can be used to "map" subsurface layers and features. Seismic surveys can be used to check for foundation stability, detect groundwater, locate mineral deposits (coal), and search for oil and gas. Most commercial seismic surveying is carried out for the energy sector (Gulland and Walker, 1998). Two general types of seismic surveys are conducted in the GOM relative to oil and gas operations. High-resolution site surveys collect data up to 1 km (0.6 mi) deep through bottom sediments and are used for initial site evaluation for potential structures as well as for exploration. This involves a small vessel and usually a single acoustic source and is also usually restricted to small areas, most often a single lease site. Deep seismic surveys involve a larger "standard" survey vessel and an airgun array. Deep seismic surveys may be 2D, 3D, 3D WAZ, or 3D coil.

Seismic exploration and development surveys are often conducted over large survey areas (multiple leases and blocks) and obtain information on geological formations to several thousands meters below the ocean floor. For "2D" surveys, a single streamer (with hydrophones) is towed behind the survey vessel, together with a single source (airgun array) (Gulland and Walker, 1998). Seismic vessels generally operate at low hull speeds (<10 knots) and follow a systematic pattern during a survey, typically a simple perpendicular grid pattern for 2D work with lines no closer than half a kilometer.

In simplistic terms, "3D" surveys collect a very large number of 2D parallel slices, perhaps with line separations of only 25-30 m (82-98 ft) since the vessel may tow multiple streamers simultaneously. A 3D survey may take months to complete and involves a precise definition of the survey area and transects, usually a series of passes to cover a given survey area (Caldwell, 2001). In 1984, industry operated the first twin streamers. By 1990, industry achieved a single vessel towing two airgun sources and six streamers. Industry continues to increase the capability of a single vessel, now using eight streamer/dual source configurations and multi-vessel operations (Gulland and Walker, 1998). For exploration surveys, 3D methods represent a substantial improvement in resolution and useful information relative to 2D methods. Many areas in the GOM previously surveyed using 2D have been or will be surveyed using 3D. It can be assumed that, for new deepwater areas with existing 2D data, 3D surveys would be the preferred method for advanced seismic exploration, until and if better technology evolves.

The WAZ and coil surveys represent a new generation of 3D seismic acquisition since 2005. Developed to improve illumination in areas that have subsalt prospectivity, these surveys involve multiple source vessels in conjunction with multiple receivers. The sources are not fired simultaneously but are flip-flopped to provide a richer areal volumes of raw data, which are then processed for improved subsalt illumination, as well as signal-to-noise ratio compared with conventional seismic.

The acquisitional geometries of WAZ vs. coil surveys are the differences. The WAZ employs multiple vessels traveling in the same direction with lead vessels and trailing vessels (although this numbers may vary), forming roughly a moving rectangle. Coil surveys, although also involving multiple vessels, collect a coiled spring-type pattern with the vessels maintaining a fixed maximum diameter presence during acquisition.

A typical airgun array used in all 3D surveys, including WAZ and coil, would involve 15-30 individual guns. The firing times of the guns are staggered by milliseconds (tuned) in an effort to make the farfield noise pulse as coherent as possible. In short, the intent of a tuned airgun array is to have it emit a very symmetric packet of energy in a very short amount of time, and with a frequency content that penetrates well into the earth at a particular location (Caldwell, 2001). In WAZ and coil surveys, these sources are alternated between source vessels. The noise generated by airguns is intermittent, with pulses generally less than one second in duration. Airgun arrays produce noise pulses with very high peak levels. The pulses are a fraction of a second and repeat every 5-15 seconds. In other words, while airgun arrays are by far the strongest sources of underwater noise associated with offshore oil and gas activities, because of the short duration of the pulses, the total energy is limited (Gordon and Moscroup, 1996). At distances of about 500 m (1,640 ft) and more (farfield), the array of individual guns would effectively appear to be a single point source (Caldwell, 2001). In the past, sound-energy levels were expected to be less than 200 dB re^{-1}µPa-m (standard unit for source levels of underwater sound: 200 decibels, reference pressure 1 micropascal, reference range 1 meter) at distances beyond 90 m from the source (Gales, 1982). Gulland and Walker (1998) state a typical source would output approximately 220 dB re^{-1}µPa-m, although the peak-to-peak source level directly below a seismic array can be as high as 262 dB re^{-1}µPa-m (Davis et al., 1998). Recent work by Tolstoy et al. (2009) in the Gulf of Mexico suggests that for deep water (~1,600 m; 5,249 ft) the 180-dB radii would occur at less than 1 km (0.6 mi) from the source, while in shallow waters (~50 m; 164 ft), the 180-dB radii would be considerably larger (e.g., ~1.1 km; 0.7 mi). The 180 dB re^{-1}µPa-m level is an estimate of the threshold of sound energy that may cause hearing damage in cetaceans (U.S. Dept. of the Navy, 2001). Until further studies are completed, NMFS continues to use this estimated threshold. It is unclear which measurements of a seismic pulse provide the most helpful indications of its potential impact on marine mammals (Gordon et al., 1998). Gordon et al. speculate that peak broadband pressure and pulse time and duration would be most relevant at short ranges (hearing damage range) while sound intensity in 1/3 octave bands is a more useful measurement at distance (behavioral effects).

Information on drilling noise in the GOM is unavailable to date. From studies mostly in Alaskan waters, drilling operations often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are apparently noisier than semisubmersibles (Richardson et al., 1995). Sound and vibration paths to the water are through either the air or the risers, in contrast to the direct paths through the hull of a drillship.

Machinery noise generated during the operation of fixed structures can be continuous or transient, and variable in intensity. Underwater noise from fixed structures ranges from about 20 to 40 dB above background levels within a frequency spectrum of 30-300 hertz (Hz) at a distance of 30 m (98 ft) from the source (Gales, 1982). These levels vary with type of platform and water depth. Underwater noise from platforms standing on metal legs would be expected to be relatively weak because of the small surface area in contact with the water and the placement of machinery on decks well above the water.

Aircraft and vessel support may further ensonify broad areas. Noise generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft while between platforms.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, 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). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size, laden or not, 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 unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). In the immediate vicinity of a service vessel, noise could disturb marine mammals; however, this effect would be limited in area and duration.

3.1.1.7. Major Sources of Oil Inputs in the Gulf of Mexico

Petroleum hydrocarbons can enter the GOM from a wide variety of sources. The major sources of oil inputs in the GOM are natural seepage, permitted produced-water discharges, land-based discharges, and accidental spills. Numerical estimates of the contributions for these sources to the GOM coastal and offshore waters are shown in **Tables 3-8 and 3-9**. The information presented in this EIS is based on the National Research Council's (NRC's) *Oil in the Sea III: Inputs, Fates, and Effects* (NRC, 2003) and is summarized below. These values include permitted oil discharges and not just spills.

The GOM comprises one of the world's most prolific offshore oil-producing provinces as well as having heavily traveled tanker routes. Nevertheless, inputs of petroleum from onshore sources far outweigh the contribution from offshore activities. Human use of petroleum hydrocarbons is generally concentrated in major municipal and industrial areas situated along coasts or large rivers that empty into coastal waters.

3.1.1.7.1. Natural Seepage

Natural seeps provide the largest petroleum input to the offshore GOM, about 95 percent of the total. Mitchell et al. (1999) estimated a range of 280,000-700,000 bbl per year (40,000-100,000 tonnes per year), with an average of 490,000 bbl (70,000 tonnes) for the northern GOM, excluding the Bay of Campeche. Using this estimate and assuming seep scales are proportional to surface area, the NRC (2003) estimated annual seepage for the entire GOM at ~980,000 bbl (140,000 tonnes) per year, or about 3 times the estimated amount of oil spilled by the 1989 *Exxon Valdez* event (~270,000 bbl) (Steyn, 2010) or a quarter of the amount released by the DWH event (4.9 million bbl of oil) (Lubchenco et al., 2010). As seepage is a natural occurrence, the rate of ~980,000 bbl (140,000 tonnes) per year is expected to remain unchanged throughout the 40-year cumulative analysis period.

3.1.1.7.2. Produced Water

During OCS operations, small amounts of oil are routinely discharged in produced water, which is treated and discharged overboard according to USEPA regulations. Based on the volume of produced water generated, an average of about 17,500 bbl of oil is discharged in the Gulf of Mexico OCS each year (Etkin, 2009). The NRC (2003) estimates the discharge of 4,130 bbl (590 tonnes) per year petroleum hydrocarbons to the coastal western GOM and 11,900 bbl (1,700 tonnes) to the offshore western GOM through produced-water discharges.

3.1.1.7.3. Land-Based Discharges

Land-based sources provide the largest petroleum input to the coastal waters of both the western and eastern GOM. For coastal waters, 77,000 bbl (11,000 tonnes) of petroleum hydrocarbons enter the western GOM and 11,200 bbl (1,600 tonnes) enter the eastern GOM from land-based discharges. Land-based sources include residual petroleum hydrocarbons in municipal and industrial wastewater treatment facility discharges as well as urban run-off. The Mississippi River carries the majority of petroleum hydrocarbons into GOM waters from land-based drainage that occurs far upriver. With increased urbanization, particularly in coastal areas, the amount of impervious paved surface increases and oil contaminants deposited on these roads and parking lot surfaces are washed into adjacent streams and waterbodies.

Land-based sources provide the largest petroleum input to the coastal waters of the GOM. Land-based sources include residual petroleum hydrocarbons in municipal and industrial wastewater treatment facility discharges as well as urban runoff. The Mississippi River carries the majority of petroleum hydrocarbons into GOM waters from land-based drainage that occurs far upriver. With increased urbanization, particularly in coastal areas, the amount of impervious paved surface increases, and oil contaminants deposited on these roads and parking lot surfaces are washed into adjacent streams and waterbodies.

3.1.1.7.4. Spills

Oil spills occur during the production, transportation, and consumption of oil. The composition of spilled hydrocarbons includes crude oil, refined fuels such as diesel during transport, and storage and spills during consumption. In the GOM, spills will vary according to activities conducted in the area. For coastal waters, 6230 bbl (890 tonnes), 5390 bbl (770 tonnes), and 5180 bbl ((740 tonnes) enter the western GOM from pipeline spills, tank vessel spills during transportation, and coastal facility spills, respectively (NRC, 2003). For offshore waters, much less oil is spilled due to pipeline breaks (420 bbl [60 tonnes]) than in coastal waters. The pipelines are less accessible on the seafloor and are thus protected. However, in offshore waters much more oil is spilled from tank vessels, 10,500 bbl (1,500 tonnes). The volume spilled from tank vessels continues to decline due to more stringent requirements including double-hulled vessels. The amount of oil spilled in U.S. waters from tankers (tank ships) has decreased by 90 percent in the decade 1998-2007, compared with previous decade 1988-1997 (Etkin, 2009). Tank barges in U.S. waters showed a nearly 67 percent reduction in the same period compared with the previous decade (Etkin, 2009). The large volume of transportation-related spills is due to the extensive petroleum industry in the region, including production, refining, and distribution.

The sum of spills from marine platforms (50 tons per year) and pipelines (60 tons per year) was 770 bbl per year during the years 1990-1999 (110 tons per year) (NRC, 2003). The volume rises to a total of 7,630 bbl/year when platform and pipeline spills in GOM coastal waters are added to marine water spills. A far greater cumulative amount of oil enters coastal waters from human activities than enters offshore waters. However, as illustrated by the DWH event, offshore activities have the potential to cause a catastrophic spill.

3.1.1.7.4.1. Trends in Reported Spill Volumes and Numbers

Several additional reports that characterize global or national spill statistics have been published more recently than *Oil in the Sea* (NRC, 2003). Although the values may not be comparable, they provide interesting details about relative spill volumes and trends.

Due to the ubiquitous occurrence of tar on beaches and dissolution into adjacent waters at locations that were distant from any natural sources, the Oil Input Working Group of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection prepared an estimate of global oil inputs to the sea (GESAMP 1993 and 2007). This group paid particular attention to improving methods to estimate oil releases from shipping activities. Amounts of oil from operational discharges and spills are both included. The estimated global average annual inputs of oil entering the marine environment from ships and other sea-based activities, based on 1988-1997 data, is shown in **Table 3-10** (GESAMP, 2007). Inputs from offshore exploration and production in this table include operational discharges and spills. The global estimate for operational discharges is 114,450 bbl/year, and the accidental releases from marine platforms and pipelines are 23,800 bbl/year. The total amount of the oil released to global oceans from offshore oil and gas activities as well as accidents is 140,000 bbl/year or 2 percent of the volume entering the marine environment.

The USCG prepares a report, *Polluting Incidents In and Around U.S. Waters, A Spill/Release Compendium* (U.S. Dept. of Homeland Security, CG, 2010a). The most recent version, 1969-2009, was published in April 2011. This document summarizes spills reported to the USCG that occurred on navigable waters including rivers, lakes and harbors, the territorial seas (0-3 mi [0-5 km] from the coastline), the contiguous zone (3-12 mi [5-19 km] from the coastline) and the marine environment. The data include over 100 different petroleum and nonpetroleum oils (food oils) and over 50 sources including barges, tanks, pipelines, and waterfront facilities. The data were gathered via four different systems that have been in place over the years; the most recent is the Marine Information for Safety and Law Enforcement system, in place since 2001.

In the accumulated data, the USCG notes that the greatest volume spills are crude and heavy oil. Most spills and spill volume occurred in the GOM coastal waters and the Mississippi, Ohio, and Arkansas Rivers. At the national level, for the years 1999 through 2009, 26 percent of the volume of oil spilled came from tank vessels (e.g., ships/barges); 35 percent from facilities and other nonvessels; 26 percent from nontank vessel; 6 percent from pipelines; and 8 percent from mystery spills. In 1973 through 2008, tankers and tank barges were responsible for 45 percent of the total spillage in the years (U.S. Dept. of Homeland Security, CG, 2010a). The number and volume of oil spilled in the Gulf of Mexico from 2001 through 2009, as reported to USCG, is presented in **Table 3-11**.

Etkin (2009) examined spills in the United States related to both onshore and offshore activities though 2007. The most recent decade analyzed overlaps with the final 2 years of the NRC data. Much more information is available in this 65-page report than is summarized in the following paragraphs. For the decade 1998-2007 all of the oil spilled from offshore platforms was spilled on the OCS in Federal waters. No spills from platforms in State waters were reported. The volume of oil type spilled was about equally divided between crude oil and diesel fuel. However, the amount of diesel spilled in 2005 was three times greater than the amount spilled in any other year due to the hurricanes that occurred in the Gulf of Mexico. From 1998 through 2007an average of 1,273 bbl of oil/year spilled from GOM platforms and 2,613 bbl of oil/year spilled from GOM pipelines. Only about 10 bbl of oil/year spilled from vessels that supply the offshore industry during the same 10-year interval. For all regions, the Gulf of Mexico, Pacific, and Alaska, total spillage was reduced by 61 percent in the 10-year period from 1998 through 2007, as compared with the previous decade of 1989 through 1997.

Etkin (2009) examined the most common causes of spill incidents and the volume associated with the incident. For the decade 1998 through 2007, the causes of platform spills are as follows: hurricanes were associated with 47 percent of spill incidents and 85 percent of the spill volume; structural failure, such as corrosion was associated with 26 percent of spill incidents and 4 percent of spill volume; and operator error was associated with 18 percent of incidents and 8 percent of volume. The cause and volume of pipeline spills during this same 10-year period were as follows: hurricanes were associated with 58 percent of incidents and 43 percent of volume; structural issues were associated with 29 percent of incidents and 41 percent of volumes; and lastly, vessel damage such as anchor drag were associated with 5 percent of incidents and 15 percent of volume. Etkin (2009) determined that, for the 10-year period 1998 through 2007, 0.0000012 bbl of oil was spilled per bbl of oil produced. Etkin estimates that offshore platforms and pipelines spilled 3,887 bbl of oil per year from 1998 through 2007.

Anderson and Labelle (USDOI, BOEMRE, 2011a) examined spills on the OCS from platforms, pipelines, vessels, and on the OCS and in coastal and offshore waters for tankers and barges. They did not include oil from permitted discharges or oil from sources unrelated to oil production or transportation. Crude oil and refined petroleum products are included. In the previous Anderson and LaBelle report (Anderson and LaBelle, 2000), they examined oil-spill incidents through 1999. In this report, they review the entire record of spills and several shorter intervals from the past 15 or 20 years, through 2009 and 2010 to show how the DWH event influences the spill statistics. The report also notes the external factors that have influenced spill rates. These are the six highly destructive hurricanes between 2002 and 2008 that destroyed or extensively damaged 305 platforms, 76 drilling rigs, and over 1,200 pipeline segments; the inclusion of "passive spills" petroleum missing based on pre-storm platform inventories; and the phasing out of single-hulled tankers. The rate of OCS platform/rig spills of ≥1,000 bbl increases in the most recent 15 years—from 0.13 (1985-1999) to 0.25 (1996-2010)—due to Hurricanes Katrina and Rita structure destruction in 2005 and the Macondo spill in 2010. Prior to these two incidents, the last United States OCS platform/rig spills of ≥10,000 bbl was in 1980. The United States OCS pipeline rate for spills ≥1,000 bbl declined from 1.38 (1985-1999) to 0.88 spills/BBO (1996-2010).

3.1.1.7.4.2. Projections of Future Spill Events

Anderson and LaBelle (USDOI, BOEMRE, 2011a) was used to examine spill volumes, source types, and locations in the Bureau of Ocean Energy Management's WPA and CPA, and the USCG database was used for both OCS areas and in State offshore waters off the States of Texas, Louisiana, Mississippi, and Alabama. The information on the larger spills is more reliable than the information on the small spills. The distribution of spill sizes is likely to be similar to those identified in Anderson and Labelle (USDOI, BOEMRE, 2011a) for OCS spills. Ninety-six percent of spills are <1 bbl (average size = 0.05 bbl) and 98 percent of spills are <10 bbl (average size for spills 1-9 bbl = 3 bbl).

The USCG data have some shortcomings that should be noted. The data are collected from reports called into the National Response Center. The USCG does not visually verify each spill. Therefore, the volume spilled may be the initial estimate of the caller and is not updated as the actual volume of the spill is discovered. For spills of unknown source, the caller may also guess as to what type of oil, crude or fuel, was released. The database includes a latitude and longitude GPS position for each spill, as well as a verbal description of location. The verbal description may not match the position. For example, the verbal description could be Mississippi Sound, but the GPS position is actually on the OCS. For this report, location was based on the GPS position, not the verbal description of the location.

3.1.1.7.4.3. OCS-Related Offshore Oil Spills

To facilitate a discussion of projected accidental spills, BSEE subdivides the topic into spills ≥1,000 bbl and <1,000 bbl. The spills ≥1,000 bbl are routinely reported and well documented, and are thus more comprehensive and reliable than those for smaller spills.

A discussion of projected spills ≥1,000 bbl is presented in **Chapter 3.2.1.5**. The estimates are based on rates derived from historical records as discussed in Anderson and Labelle (USDOI, BOEMRE, 2011a). For the WPA, <1 spill is expected, and for the CPA, <1-1 spill is anticipated. If a spill were to occur, a volume of 2,200 bbl is anticipated (**Table 3-12**).

Estimates for the number of spills <1,000 bbl, on the OCS, related to oil and gas exploration and production are shown in **Table 3-12**. The following number of spills and median spill sizes are projected over the life of a WPA proposed action: 0- to 1.0-bbl spill size, 234-404 spills with median size <0.024 bbl; 1.1- to 9.9-bbl spill size, 7-11 spills with median spill size of 3.0 bbl; 10.0- to 49.9-bbl spill size, 2-3 spills with median spill size of 3.0 bbl; and 50.0- to 999.9-bbl spill size, 1-2 spills with median spill size of 130 bbl. The following number of spills and median spill sizes are projected over the life of a CPA proposed action: 0- to 1.0- bbl spill size, 929-1,806 spills with median size <0.024 bbl; 1.1- to 9.9-bbl spill size, 26-51 spills with median spill size of 3.0 bbl; 10.0- to 49.9-bbl spill size, and 50.0- to 999.9-bbl spill size, 5-11 spills with median spill size 130 bbl. The range of spills projected for combined spill size categories <1-999.9 bbl spilled is 244-420 spills for the WPA and 968-1,884 spills for the CPA over the life of a proposed action. See **Chapter 3.1.1.7** for additional information.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.7.4.4. Non-OCS-Related Offshore Spills

Non-OCS-related offshore spills ≥1,000 bbl will occur from the extensive maritime barging and tankering operations that occur in offshore waters of the GOM. The analysis of spills from tankers and barges ≥1,000 bbl is based on data obtained from USCG and analyzed by BSEE.

The spill event that stands out in the 1996- 2009 dataset is the November 11, 2005, spill of #6 fuel oil (43,491 bbl) that occurred when the integrated tug and barge *Rebel/DBL 152* struck a platform that had moved off location due to a hurricane. Following the period of more frequent hurricanes, this Agency issued NTL 2009-G16, requiring GPS devices on MODU’s so that if one was lost following a hurricane, its location could be identified. Three additional spills ≥1,000 bbl occurred in the CPA for which the source is unknown.

Non-OCS-related offshore spills <1,000 bbl will occur from the extensive operations that occur in offshore waters of the WPA. From 1996 to 2009, there were 165 spills in the WPA where the source was known and was not related to OCS exploration and production activity. Also, there were 290 spills recorded where the source was unknown and possibly could have been related to OCS exploration and production activity. Most of these spills were below 1 bbl in size.

For the same time period, there were 3,039 spills <1,000 bbl in the CPA where the source was not related to OCS exploration and production activity. There were also 4,081 spills reported where the source was unknown and so might have been related to OCS exploration and exploration activity. Most of these spills were below 1 bbl in size.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.7.4.5. OCS-Related Coastal Spills

The OCS-related spills ≥1,000 bbl may occur in coastal waters. Pipeline ruptures, fuel spills during supply vessel and service-vessel trips, and spills that occur on the OCS but that are transported into State offshore waters are all potential Federal activity-related sources for the oil observed in State offshore waters. Very few spills of ≥1,000 bbl occurred in coastal waters. None of them were related to OCS activity. However, oil from the OCS may have been in the tanks that were blown over by Hurricanes Katrina and Rita.

The OCS-related spills <1,000 bbl may occur in coastal waters. For spills <1,000 bbl, there are also many spills that were observed and reported but for which the source is unknown.

Reported spills from 1996 to 2009 in the State offshore waters 0-3 nmi (0-3.4 mi; 0-6 km) from the coast of Texas, Louisiana, Mississippi, and Alabama were counted. For spills <1,000 bbl, there are also many spills that were observed and reported but that the source is unknown. There were assumed to be related to OCS exploration and production activity in the preceding section. In Texas, 120 spills from known sources, 71 spills from unknown sources, 52 spills from oil exploration and production sources that could have been related to OCS activity, and 7 tank or barge spills occurred over a 14-year period. In Louisiana, 718 spills from known sources, 1,432 spills from unknown sources, 863 spills from oil exploration and production sources that could have been related to OCS activity, and 13 tank or barge spills occurred over a 14-year period. In Alabama, 95 spills from known sources, 7 spills from unknown sources, 22 spills from oil exploration and production sources that could have been related to OCS activity, and 1 tank or barge spills occurred over a 14-year period. In Mississippi, 375 spills from known sources, 40 spills from unknown sources, 12 spills from oil exploration and production sources that could have been related to OCS activity, and 5 tank or barge spills occurred over a 14-year period. Further discussion of these records and an estimate of the volume of oil released to coastal waters are provided in **Chapter 3.2.1.5**.

Spill sizes are likely to be similar to those identified by Anderson and LaBelle (USDOI, BOEMRE, 2011a) for OCS spills. Ninety-six percent of spills are <1 bbl (average size = 0.05 bbl) and 98 percent of spills are <10 bbl (average size for spills 1-9 bbl = 3 bbl).

3.1.1.7.4.6. Non-OCS-Related Coastal Spills

For the 14-year period that was reviewed, there were no spills ≥1,000 bbl in the coastal waters of Texas, Alabama, or Mississippi from any source. There were two spills ≥1,000 bbl in Louisiana coastal waters where the source was a fixed platform located in State waters. In 2000, there was a fixed platform spill of 1,000 bbl at an unspecified location in Louisiana coastal waters and in May 2007, there was 1,200 bbl spill at Bay Marchand Block 176 which resulted from a loose flange below the wellhead. Additionally there were spills in waters such as the Houston Ship Channel, and the Mississippi River below Baton Rouge and spills due to Hurricane Katrina that occurred within the jurisdiction of the EPA but which are included in USCG reports because the USCG assisted with the response or the clean-up.

Non-OCS-related spills <1,000 bbl occur regularly in coastal waters, particularly Louisiana waters. Commercial shipping, the extensive fish and shellfish industry, and State offshore oil and gas activities are all potential sources for the oil observed in State offshore waters. For spills <1,000 bbl, there are many spills that are observed and reported but for which the source is unknown. These spills were assumed to be related to OCS exploration and production activity in the preceding section. Further discussion of these records and an estimate of the volume of oil released to coastal waters is provided in **Chapter 3.2.1.5**.

Spill sizes are likely to be similar to those identified in Anderson and LaBelle (USDOI, BOEMRE, 2011a) for OCS spills. Ninety-six percent of spills are <1 bbl (average size = 0.05 bbl) and 98 percent of spills are <10 bbl (average size for spills 1-9 bbl = 3 bbl).

3.1.1.7.4.7. Other Sources of Oil

Volatile organic components (VOC's) present in the crude or refined hydrocarbons escape to the atmosphere during all phases of production, transportation, and consumption. They are then deposited into surface waters through wet and dry deposition and gas absorption. In both coastal and offshore areas, the greatest amount of VOC release to the atmosphere is during the consumption of petroleum, and sources include emissions during internal combustion, from power generating plants, and from industrial manufacturing. In the offshore OCS, 8,400 bbl (1,200 tonnes) are released to the western GOM and 11,200 bbl (1,600 tonnes) are released to the eastern GOM (NRC, 2003). These totals include emissions of VOC from petroleum consumption during from shore-based, coastal, and marine activities, which are then transported and deposited in the offshore waters.

On occasion, aircraft carry more fuel than they can safely land with so fuel is jettisoned into offshore marine waters. The amount of 1,120 bbl (160 tonnes) per year was estimated for the combined offshore western and eastern GOM.

Air pollution issues have prompted the USEPA to address the incomplete combustion of fuel and fuel additives in two-stroke engines, including outboard engines, lawn mowers, chain saws, and jet skis. The increased population in coastal areas uses an increased number of recreational water vessels such as motor boats and jet skis. *Oil in the Sea* (NRC, 2003) was able to quantify losses of petroleum hydrocarbons from recreational vessels to the coastal waters of the western and eastern GOM as 5,390 bbl (770 tonnes per year).

3.1.1.8. Offshore Transport

3.1.1.8.1. Pipelines

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the GOM. A mature pipeline network exists in the GOM to transport oil and gas production from the OCS to shore. There are currently 109 OCS-related pipeline landfalls (pipelines that have at one time or another carried hydrocarbon product from the OCS) in the Louisiana Coastal Area (LCA) (USDOI, MMS, 2007a; **Table 3-13**). Included in this number of pipeline landfalls is a subset of 47 pipeline systems under DOT jurisdiction originating in Federal waters and terminating onshore or in Louisiana State waters (Gobert, 2010; **Figure 3-5**). There are 69 OCS-related pipelines that transition into Texas State lands or that make landfall onshore, many of which switch back across this boundary (**Figure 3-5)**. The BSEE and DOT share responsibility for pipeline regulation on the OCS in the transition between Federal and State waters. The BSEE has jurisdiction over producer-operated pipelines that extend upstream from the wellbore to the point downstream (the last valve on production infrastructure) on the OCS at which responsibility transfers from a producing operator to a transporting operator. The DOT's jurisdiction lies with transporter-operated pipelines that tend to be larger diameter trunk lines that service multiple facilities or pipeline tie-ins from offshore.

The OCS-related pipelines nearshore and onshore may merge with pipelines carrying materials produced in State lands for transport to processing facilities or to connections with pipelines located farther inland. At present, all gas production and >99 percent of oil production from the offshore GOM is transported to shore by pipeline. Gas pipelines account for 62 percent of the total pipeline length approved in deep water since 1990.

Natural gas transportation by means other than pipelines, for example as LNG, is possible, but is not part of a WPA or CPA proposed action or the OCS Program scenario.

Newer installation methods have allowed the pipeline infrastructure to extend farther into deep water. At present, the deepest pipeline in the Gulf is in water 2,700 m (8,858 ft) deep. More than 500 pipelines reach water depths of 400 m (1,312 ft) or more, and over 400 of those pipelines reach water depths of 800 m (2,625 ft) or more. These technical challenges are described in more detail in *Deepwater Gulf of Mexico 2006: America's Expanding Frontier* (USDOI, MMS, 2006a).

Pipeline Installation and Maintenance

Pipelines constructed in water depths <200 ft (61 m) are potential snags for anchors and trawls, and account for 62 percent of the total pipeline length in Federal waters. According to BSEE regulations (30 CFR 250.1003(a)(1)), pipelines with diameters $\geq 8^5/_8$ inches that are installed in water depths <60 m (197 ft) are to be buried to a depth of at least 3 ft (1 m) below the mudline. The regulations also provide for the burial of any pipeline, regardless of size, if BSEE determines that the pipeline may constitute a hazard to other uses of the OCS; in the GOM, BSEE has determined that all pipelines installed in water depths <60 m (197 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 ≤60 m (197 ft), any length of pipeline that crosses a fairway or anchorage in

Federal waters must be buried to a minimum depth of 10 ft (3 m) below mudline across a fairway and a minimum depth of 16 ft (5 m) below mudline across an anchorage area. Some operators voluntarily bury these pipelines deeper than the minimum.

Where pipeline burial is necessary, a jetting sled will be used. Such sleds are mounted with high-pressure water jets and pulled along the seafloor behind the pipelaying barge. The water jets are directed downward to dig a trench; the sled guides the pipeline into the trench. Such an apparatus can jet pipe at an average of 1.6 km/day (1.0 mi/day). The cross section of a typical jetted trench for the flowline bundles would be about 4 m^2 (43 ft^2); for deeper burial when crossing a fairway, the cross section would be about 13 m^2 (140 ft^2). The cross section of a typical jetted trench for the export and interconnecting export pipelines would be about 5 m^2; for a pipeline trench crossing a fairway, the cross section would be about 15 m^2 (161 ft^2).

Jetting disperses sediments over the otherwise undisturbed water bottom that flanks the jetted trench. The area covered by settled sediment and the thickness of the settled sediment depends upon variations in bottom topography, sediment density, and currents. Newer installation methods have allowed the pipeline infrastructure to extend to deeper water. At present, the deepest pipeline in the Gulf is in 2,700 m (8,858 ft) water depth. More than 454 pipelines reach water depths of 400 m (1,312 ft) or more, and 331 of those reach water depths of 800 m (2,625 ft) or more.

The following information is largely from this Agency's *Deepwater Gulf of Mexico 2006: America's Expanding Frontier* (UDSOI, MMS, 2006a). Pipeline installation activities in deepwater areas can be difficult both in terms of route selection and construction. Depending on the location, the sea-bottom surface can be extremely irregular and present engineering challenges (e.g., high hydrostatic pressure, cold temperatures, and darkness, as well as varying subsurface and bottom current velocities and directions). Rugged seafloor may cause terrain-induced pressures within the pipe that can be operationally problematic, as the oil must be pumped up and down steep slopes. An uneven seafloor could result in unacceptably long lengths of unsupported pipeline, referred to as "spanning," which in turn could lead to pipe failure from bending stress early in the life of the line. It is important to identify areas where significant lengths of pipeline may go unsupported. Accurate, high-resolution geophysical surveying becomes increasingly important in areas with irregular seafloor. Recent advances in surveying techniques have significantly improved the capabilities for accurately defining seafloor conditions, providing the resolution needed to determine areas where pipeline spans may occur. After analyzing survey data, the operator chooses a route that minimizes pipeline length and avoids areas of seafloor geologic structures and obstructions that might cause excessive pipe spanning, unstable seafloor, and potential benthic communities.

The BSEE's minimum cathodic protection design criteria for pipeline external corrosion protection is 20 years. For the most part, pipelines have a designed life span greater than 20 years and, if needed, can be retrofitted to increase the life span. As for internal corrosion mitigation, operators are required to monitor products transported through pipelines for corrosiveness. Based on the type of production, a company then enhances the pipeline internal corrosion protection by injecting appropriate corrosion inhibitors and monitoring effectiveness to prevent pipeline failures, thus extending the life of a pipeline. It should be noted that different products have different corrosive characteristics. Should a pipeline need to be replaced because of integrity issues, a replacement pipeline is installed or alternate routes are used to transport the products, or a combination of the two. Besides replacement because of integrity issues, a pipeline may also be required to be replaced as a result of storm or other damages. The BSEE estimates that the overall pipeline replacement over the past few years is about 1 percent of the total installed.

The greater pressures and colder temperatures in deep water present difficulties with respect to maintaining the flow of crude oil and gas through pipelines. Under these conditions, the physical and chemical characteristics of the produced hydrocarbons can lead to the accumulation of gas hydrate, paraffin, and other substances within the pipeline. These accumulations can restrict and eventually block flow if not successfully prevented and/or abated. There are physical and chemical techniques that can be applied to manage these potential accumulations. The leading strategy to mitigate these deleterious effects is to minimize heat loss from the system by using insulation. Other measures include forcing plunger-like "pigging" devices through the pipeline to scrape the pipe walls clean, and the continuous injection of flow-assurance chemicals (e.g., methanol or ethylene glycol) into the pipeline system to minimize the formation of flow-inhibiting substances. However, the great water depths of the OCS and the extreme distance to shoreside facilities make these flow-assurance measures difficult to implement and can significantly increase the cost to produce and transport the product. Companies are continuously looking for and developing new technologies such as electrically and water-heated pipelines and burial of pipelines in deepwater for insulation purposes.

Long-distance transport of multiphase well-stream fluids can be achieved with an effectively insulated pipeline. There are several methods to achieve pipeline insulation: pipe-in-pipe systems, which included electrically and water-heated pipelines; pipe with insulating wrap material; and as previously mentioned, buried pipelines where the soils act as an insulator. The design of all of these systems seeks a balance between the high cost of the insulation, the intended operability of the system, and the acceptable risk level. Such systems minimize the costs, revenue loss, and risks from the following:

- hydrate formation during steady state or transient flowing conditions;
- paraffin accumulation on the inner pipe wall that can result in pipeline plugging or flow rate reductions;
- adverse fluid viscosity effects at low temperatures that lead to reduced hydraulic performance or to difficulties restarting a cooled system after a short shut-in; and
- additional surface processing facilities required to heat produced fluids to aid in the separation processes.

Formation of gas hydrates in deepwater operations is a well-recognized and potentially hazardous operational problem in water depths >1,000 ft (300 m). Seabed conditions of high pressure and low temperature become conducive to gas hydrate formation in deepwater. Gas hydrates are ice-like crystalline solids formed by low-molecular-weight hydrocarbon gas molecules (mostly methane) combining with produced water. The formation of gas hydrates is potentially hazardous because hydrates can restrict or even completely block fluid flow in a pipeline, resulting in a possible overpressure condition. The interaction between the water and gas is physical in nature and is not a chemical bond. Gas hydrates are formed and remain stable over a limited range of temperatures and pressures.

Hydrate prevention is normally accomplished through the use of methanol, ethylene glycol, or tri-ethylene glycol as inhibitors, and the use of insulated pipelines and risers. Chemical injection is sometimes provided both at the wellhead and at a location within the well just above the subsurface safety valve. Wells that have the potential for hydrate formation can be treated with either continuous chemical injection or intermittent or “batch” injection. In many cases, batch treatment is sufficient to maintain well flow. In such cases, it is necessary only to inject the inhibitor at well start-up, and the well will continue flowing without the need for further treatment. In the event that a hydrate plug should form in a well that is not being injected with a chemical, the remediation process would be to depressurize the pipelines and inject the chemical. Hydrate formation within a gas line can be eliminated by dehydrating the gas with a glycol dehydrating system prior to input of gas into the line. In the future, molecular sieve and membrane processes may also be options for dehydrating gas. Monitoring of the dew point downstream of the dehydration tower should take place on a continuous basis. In the event that the dehydration equipment is bypassed because it may be temporarily out of service, a chemical could be injected to help prevent the formation of hydrates if the gas purchaser agrees to this arrangement beforehand.

Hydrocarbon flows that contain paraffin or asphaltenes may begin to block pipelines as these substances, which have relatively low melting points, form deposits on the interior walls of the pipe. To help ensure product flow under these conditions, an analysis should be made to determine the cloud point and hydrate formation point during normal production temperatures and pressures. To minimize the formation of paraffin or hydrate depositions, wells can be equipped with a chemical injection system. If, despite treatment within the well, it still becomes necessary to inhibit the formation of paraffin in a pipeline, this can be accomplished through the injection of a solvent such as diesel fuel into the pipeline.

Clearance of pipeline interiors is carried out by “pigs.” Pigging is a term used to describe a mechanical method of displacing a liquid in a pipeline or to clean accumulated paraffin from the interior of the pipeline by using a mechanized plunger or pig. Paraffin is a waxy substance associated with some types of liquid hydrocarbon production. The physical properties of paraffin are dependent on the composition of the associated crude oil, and temperature and pressure. At atmospheric pressure, paraffin is typically a semisolid at temperatures above about 100 ^{o}F (38 ^{o}C) and will solidify at about 50 ^{o}F

(10 °C). Paraffin deposits will form inside pipelines that transport liquid hydrocarbons and, if some remedial action such as pigging is not taken, the deposited paraffin will eventually completely block all fluid flow through the line. The pigging method involves moving a pipeline pig through the pipeline to be cleaned. Pipeline pigs are available in various shapes and are made of various materials, depending on the pigging task to be accomplished. A pipeline pig can be a disc or a spherical or cylindrical device made of a pliable material such as neoprene rubber and having an outside diameter nearly equal to the inside diameter of the pipeline to be cleaned. The movement of the pig through the pipeline is accomplished by applying pressure from gas or a liquid such as oil or water to the back or upstream end of the pig. The pig fits inside the pipe closely enough to form a seal against the applied pressure. The applied pressure then causes the pig to move forward through the pipe. As the pig travels through the pipe, it scrapes the inside of the pipe and sweeps any accumulated contaminants or liquids ahead of it. In deepwater operations, pigging will be used to remove any paraffin deposition in the pipelines as a normal part of production operations. Routine pigging will be required of oil sale lines at frequencies determined by production rates and operating temperatures. The frequency of pigging could range from several times a week to monthly or longer, depending on the nature of the produced fluid. In cases where paraffin accumulation cannot be mitigated, extreme measures can be taken in some cases such as coil tubing entry into a pipeline to allow washing (dissolving) of paraffin plugs. If that fails, then it could result in having to replace a pipeline.

Pipeline Landfalls

Up to one (i.e., 0-1) new pipeline landfall is projected per OCS lease sale (USDOI, MMS, 2007a, p. 1). The BOEM anticipates that pipelines from most of the new offshore production facilities will tie in to the existing pipeline infrastructure offshore or in State waters, which will result in few new pipeline landfalls. See **Chapter 3.1.2.1.6** for a further discussion of pipeline landfalls. Production from a WPA or CPA proposed action will contribute to the capacity of existing and future pipelines and pipeline landfalls. According to BSEE regulations (30 CFR 250.1003(a)(1)), pipelines with diameters ≥8⅝ in (22 cm) that are installed in water depths <60 m (200 ft) are to be buried to a depth of at least 3 ft (1 m) below mudline. The regulations also provide for the burial of any pipeline, regardless of size, if BSEE determines that the pipeline may constitute a hazard to other uses of the OCS in the GOM. The BSEE has determined that all pipelines installed in water depths <60 m (200 ft) must be buried. The purposes of these requirements are to (1) reduce the movement of pipelines during high sea states by storm currents and waves, (2) protect the pipeline from the external damage that could result from anchors and fishing gear, (3) reduce the risk of fishing gear becoming snagged, and (4) minimize interference with the operations of other users of the OCS. Where pipeline burial is necessary, a jetting sled would be used. Jetting disperses sediments over the otherwise undisturbed water bottom that flanks the jetted trench. The area covered by settled sediment and the thickness of the settled sediment depends upon variations in sea bottom grain size, bottom topography, sediment density, and currents. Sediment displacement due to pipeline burial is further explained in **Chapter 3.1.1.3.2.2**.

WPA Proposed Action Scenario (Typical Sale): The BOEM projects 237-554 km (147-344 mi) of new pipelines as a result of a WPA proposed action (**Table 3-2**). For a WPA proposed action, about 30-32 percent of the new pipeline length would be in water depths <60 m (197 ft), requiring burial. For a WPA proposed action, 0-1 new pipeline landfalls are projected.

CPA Proposed Action Scenario (Typical Sale): The BOEM projects 628-1,870 km (390-1162 mi) of new pipelines as a result of a CPA proposed action (**Table 3-3**). For a CPA proposed action, about 31-34 percent of the new pipeline length would be in water depths <60 m (197 ft), requiring burial. For a CPA proposed action, 0-1 new pipeline landfalls are projected.

OCS Program Cumulative Scenario (WPA, CPA, and EPA): The BOEM projects 30,428-69,749 km (18,907-43,340 mi) of new pipelines as a result of the WPA, CPA and EPA proposed lease sales and all activity associated with previous lease sales (**Table 3-4**). About 30-34 percent of the new pipeline length would be in water depths <60 m (197 ft), requiring burial. For the OCS Program, which includes proposed lease sales in the WPA, CPA and EPA, 0-12 new pipeline landfalls are projected.

The length of new pipelines was estimated using the amount of production, the number of structures projected as a result of a proposed action, and the location of the existing pipelines. The range in length of pipelines projected is because of the uncertainty of the location of new structures, which existing or proposed pipelines would be used, and where they tie in to existing lines. Many factors would affect the actual transport system, including company affiliations, amount of production, product type, and system capacity.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.8.2. Barges

The capacity of oil barges used offshore can range from 5,000 to 80,000 bbl. Barges transporting oil may remain offshore for as long as 1 week while collecting oil; each round trip is assumed to be 5 days.

It is assumed that barging will continue to account for <1 percent of the oil transported for the entire OCS Program and the WPA and CPA proposed actions. **Tables 3-2, 3-3, and 3-4** provide the percentages of oil barged to shore by subarea for the proposed actions (typical sales) and the OCS Program.

The barging of oil from offshore facilities located in the GOM has been reduced significantly compared with the 2005 statistics. Barging continues to represent a very small portion of the total volume of oil being transported from the GOM to shore. In 2010, that portion was 0.13 percent of the total volume. The total volume of oil barged in 2010 was approximately 59 percent less than was barged in 2005, while the total oil production increased by approximately 22 percent.

The number of active barging systems has also been reduced from approximately eight systems in 2005 to currently four systems. In 2010, there were 17 offshore locations that were approved to barge oil. Of these locations, 11 barged oil at some point during the year. The remaining six locations did not report any oil volumes for the entire year of 2010.

In 2010, all but one of the “active” offshore barging locations was located in the CPA. The locations east of the Mississippi River accounted for roughly 74 percent of the total barged volume. Likewise, the locations located west of the Mississippi River accounted for the remaining 26 percent. In 2010, there was only one approved barging location located in the WPA, and this location had minimal barging activity.

3.1.1.8.3. Oil Tankers

Shuttle tanker transport of Gulf of Mexico OCS-produced oil in a purpose-built FPSO system has not yet occurred; however, Petrobras had planned the Cascade-Chinook fields’ first production from an FPSO and shuttle tanker system in mid-2010. However, delays following the DWH event has made scheduling difficult to predict. An FPSO was approved in March 2011, and there is one FPSO system ready to operate in the deepwater Gulf. Tankering related to FPSO systems is projected for some future OCS operations located in deep water beyond the existing pipeline network. The FPSO’s store crude oil in tanks in the hull of the vessel and periodically offload the crude to shuttle tankers or oceangoing barges for transport to shore. The FPSO’s may be used to develop marginal oil fields or used in areas remote from the existing OCS pipeline infrastructure, especially development in the Lower Eocene Wilcox trend (Walker Ridge leasing area) that is far from most existing pipeline networks. As a result of the WPA and CPA proposed actions, the use of FPSO’s and shuttle tankering are only projected in water depths >800 m (2,625 ft). Shuttle tankers would be used to transport crude oil from FPSO production systems to Gulf Coast refinery ports or to offshore deepwater ports such as the Louisiana Offshore Oil Port. The shuttle tanker design and systems would be in compliance with USCG regulations. Under the Jones Act and OPA requirements, shuttle tankers would be required to be double hulled. In the Gulf, the maximum size of shuttle tankers is limited primarily by the 34- to 47-ft (10- to 14-m) water depths. Because of these depth limitations, shuttle tankers are likely to be 500,000-550,000 bbl in cargo capacity.

Offloading operations involve the arrival, positioning, and hook-up of a shuttle tanker to the FPSO. Shuttle tankers could maintain their station during FPSO offloading operations using several techniques. These include side-by-side mooring to the FPSO, use of a hawser mooring system with or without thruster assist, or by use of a dynamic positioning system that maintains the vessel’s station by use of thrusters rather than mooring lines. Hawser mooring systems used in a tandem offloading configuration is the most likely configuration for FPSO offloading operations in the GOM. Offloading would occur at an average rate 50,000 barrels per hour. During the FPSO offloading procedure, the shuttle tanker would continue to operate its engines in an idle mode so that any necessary maneuvers of the vessel could be promptly executed.

Tandem offloading would occur under maximum wave height limitations of 3.5 m (11.5 ft) for hook up/connection and 4.5 m (14.8 ft) for disconnect. These wave height limitations are currently being used in the North Sea. Hook-up is accomplished by the use of a retractable hose and a messenger line that is fired from the FPSO to the shuttle tanker via compressed air. The hawser and hose(s) are then pulled over to the shuttle tanker and connected. Cargo oil would be offloaded to the shuttle tanker using the FPSO's main cargo pumps, with oil being routed through a deck line to a stern offloading station, and then through a floating hose to the midship loading manifold of the tanker. Safety features, such as marine break-away offloading hoses and emergency shut-off valves, will be incorporated in order to minimize the potential for, and size of, an oil spill. In addition, weather and sea-state limitations will be established to further ensure that hook-up and disconnect operations will not lead to accidental oil release. A vapor recovery system between the FPSO and shuttle tanker will be employed to minimize release of fugitive emissions from cargo tanks during offloading operations.

To develop a scenario for analytical purposes, the following assumptions are made regarding future OCS oil transportation by shuttle tanker:

- advances in pipelaying technology will keep pace with the expansion of the oil industry into the deeper waters of the Gulf beyond the continental slope;
- all produced gas will be piped;
- tankering will not occur from operations on the continental shelf;
- tankering will only take place from marginal fields or fields in areas remote from the existing OCS pipeline infrastructure; and
- offloading frequency for an FPSO would be once every 3 days during peak production.

The number of shuttle tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000-bbl capacity, offloading would occur once every 3.3 days. This would equate to a 54.75-MMbbl production with 110 offloading events and shuttle tanker transits to Gulf coastal or offshore ports annually per FPSO.

The FPSO systems are suitable for the light and intermediate oils of the GOM, as well as heavier oil, such as the heavy oil Brazil plans to produce offshore in deep water. The number of shuttle-tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers.

WPA Proposed Action Scenario (Typical Sale): The BOEM projects 0-1 FPSO systems could result from a WPA proposed action.

CPA Proposed Action Scenario (Typical Sale): The BOEM projects 0-1 FPSO systems could result from a CPA proposed action.

OCS Program Cumulative Scenario (WPA, CPA, and EPA): The BOEM projects 0-6 FPSO systems could result from the OCS Program. Zero to one systems are projected within the WPA and 0-5 systems are projected within the CPA.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.8.4. Service Vessels

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. A trip is considered the transportation from a service base to an offshore site and back, in other words a round trip. Based on BOEM calculations, each vessel makes an average of eight round trips per week for 42 days in support of drilling an exploration well and six round trips per week for 45 days in support of drilling a development well. A platform in shallow water (<400 m; 1,312 ft) is estimated to require one vessel trip every 10 days over its 25-year production life. A platform in deep water (>1,000 ft; 305 m) is estimated to require one vessel trip every 1.75 days over its 25-year production life. All trips are assumed to originate from the designated service base.

WPA Proposed Action Scenario (Typical Sale): A WPA proposed action is estimated to generate 64,000-74,000 service-vessel trips over the 40-year period (**Table 3-2**) or 1,600-1,850 trips annually. **Table 3-14** indicates over 1.12 million service-vessel trips occurred on Federal navigation channels, ports, and OCS-related waterways in 2009. The number of service-vessel trips projected annually for a WPA proposed action would represent <1 percent of the total annual traffic on these OCS-related waterways.

CPA Proposed Action Scenario (Typical Sale): A CPA proposed action is estimated to generate 94,000-168,000 service-vessel trips over the 40-year period (**Table 3-3**) or 1,600-4,200 trips annually. **Table 3-14** indicates over 1.12 million service-vessel trips occurred on Federal navigation channels, ports, and OCS-related waterways in 2009. The number of service-vessel trips projected annually for a CPA proposed action would represent <1 percent of the total annual traffic on these OCS-related waterways.

OCS Program Scenario: The BOEM estimates the OCS Program would generate 3,310,000-4,382,000 service-vessel trips over the 40-year period (**Table 3-4**) or 82,750-109,550 trips annually. **Table 3-14** indicates over 1.12 million service-vessel trips occurred on Federal navigation channels, ports, and OCS-related waterways in 2009.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.8.5. Helicopters

Helicopters are 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. In addition, equipment and supplies are sometimes transported. An operation is considered a take off and landing.

Deepwater operations require helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating costs. There are several issues of concern for the helicopter industry's future. Since the tasks the offshore helicopter industry provides are the same tasks supply vessels provide, they are competition for one another. Fast boats are beginning to erode the helicopter industry's share of the offshore transportation business, particularly in shallow water. The exploration and production industry is outsourcing more and more operations to oil-field support companies who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

To meet the demands of deepwater activities, the offshore helicopter industry is purchasing new helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating cost. Also, instead of running their own fleets, oil and gas companies are increasingly subcontracting all helicopter support to independent contractors who are very cost conscious. The number of helicopters operating in the GOM is expected to decrease in the future, and helicopters that do operate are expected to be larger and faster.

The WPA and CPA proposed actions and OCS Program scenarios below use the current level of activity as a basis for projecting future helicopter operations. Helicopters are 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. In addition, equipment and supplies are sometimes transported by helicopter. The Federal Aviation Administration (FAA) regulates helicopter flight patterns. Because of noise concerns, FAA Circular 91-36C encourages pilots to maintain higher than minimum altitudes near noise sensitive areas. Corporate policy (for all helicopter companies) 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 and drilling rigs. When flying over land, the specified minimum altitude is 1,000 ft (305 m) over unpopulated areas and coastlines, and 2,000 ft (610 m) over populated areas and sensitive areas including national parks, recreational seashores, and wildlife refuges. 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.

According to the Helicopter Safety Advisory Conference (2010), from 1996 to 2010, helicopter operations (take offs and landings) in support of Gulfwide OCS operations have averaged, annually, about 1.4 million operations, 3.0 million passengers, and 400,000 flight hours. There has been a decline in helicopter operations from 1,668,401 in 1996 to 1,397,508 in 2009 and 938,690 in 2010 (Helicopter Safety Advisory Conference, 2010).

WPA Proposed Action Scenario: There are 290,000-605,000 helicopter trips projected over the 40-year period for a WPA proposed action (**Table 3-2**), or 7,250-15,125 trips annually.

CPA Proposed Action Scenario: There are 696,000-1,815,000 helicopter trips projected over the 40-year period for a CPA proposed action (**Table 3-3**), or 17,400- 45,375 trips annually.

OCS Program Cumulative Scenario: The BOEM projects 28-56 million helicopter trips for the OCS Program for the years 2012-2051 (**Table 3-4)**. This equates to an average rate of 700,000-1,400,000 operations annually.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.1.9 Safety Issues

3.1.1.9.1. Hydrogen Sulfide and Sulfurous Petroleum

Sulfur may be present in oil as elemental sulfur, within gas as H_2S, or within organic molecules, all three of which vary in concentration independently. Safety and infrastructure concerns include the following: irritation, injury, and lethality from leaks; exposure to sulfur oxides produced by flaring; equipment and pipeline corrosion; and outgassing and volatilization from spilled oil.

Sour oil and gas occur sporadically throughout the Gulf of Mexico OCS, primarily off the Louisiana, Mississippi, and Alabama coasts. Sour hydrocarbon tends to originate in carbonate source or reservoir rocks that may not have abundant clay minerals that serve as a binder for elemental sulfur. If not bound in clay minerals, it remains free and can become a part of any hydrocarbon produced or sourced from that rock.

Deep gas reservoirs on the GOM continental shelf are likely to have high corrosive content, including H_2S. There is some evidence that petroleum from deepwater areas may be sulfurous, but exploration wells have not identified deepwater areas that are extraordinarily high in H_2S concentration.

The BOEM reviews all exploration and development plans in the Gulf of Mexico OCS for the possible presence of H_2S in the area(s) identified for exploration and development activities. Activities determined to be associated with a presence of H_2S are subjected to further review and requirements. Federal regulations at 30 CFR 250.490 require all lessees, prior to beginning exploration or development operations, to request a classification of the potential for encountering H_2S. The classification is based on previous drilling and production experience in the areas surrounding the proposed operations, as well as other factors.

All operators on the OCS involved in production of sour gas or oil (i.e., >20 ppm) are also required to file an H_2S Contingency Plan. This plan lays out procedures to ensure the safety of the workers on the production facility. In addition, all operators are required under 30 CFR 250.107 to adhere to the National Association of Corrosion Engineers' (NACE) *Standard Material Requirements—Methods for Sulfide Stress Cracking and Stress Corrosion Cracking Resistance in Sour Oilfield Environments* (NACE MR0175-2003) (NACE, 2003) as best available and safest technology. These engineering standards preserve the integrity of infrastructure through specifying equipment to be constructed of materials with metallurgical properties that resist or prevent sulfide stress cracking and stress corrosion cracking in the presence of sour gas. This Agency issued a final rule (30 CFR 250.490; *Federal Register*, 1997a) 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.

3.1.1.9.2. Shallow Hazards

The type of high-resolution seismic surveys that are deployed to collect the data used for shallow hazards analyses are described in **Chapter 3.1.1.2.1**.

Shallow hazard assessments are required by 30 CFR 550.214 and 30 CFR 550.244; NTL 2008-G05, "Shallow Hazards Program," explains the requirements for these surveys and their reports. Included in shallow hazard assessment is a structural and stratigraphic interpretation of seismic data to qualitatively delineate abnormal pressure zones, shallow free gas, seafloor instability, shallow waterflow, and gas hydrates.

The objective of the shallow hazard assessment is to identify, map, and delineate seafloor, shallow subsurface geologic features, and man-caused obstructions that may impact proposed oil and gas operations, which include the following:

- seafloor geologic hazards such as fault scarps, gas vents, unstable slopes, and reefs;
- shallow subsurface geologic hazards such as faults, gas hydrates and gas-charged sediments, buried channels, and abnormal pressure zones; and
- synthetic hazards such as pipelines, wellheads, shipwrecks, military ordnance (offshore disposal sites), and debris from oil and gas operations.

The shallow hazards survey is also used to identify and map geologic features in the vicinity of proposed wells, platforms, anchors and anchor chains, mounds or knolls, acoustic void zones, gas- or oil-charged sediments, or seeps associated with surface faulting that may be indicative of ocean-bottom chemosynthetic communities.

Since 1987, operators have reported shallow waterflow events to this Agency. These events are a phenomenon encountered in water depths exceeding 600 ft (183 m). Reported waterflows are between a few hundred feet to more than 4,000 ft (1,219 m) below the seafloor. Water flowing up and around the well casing and annulus may deposit sand or silt on the seafloor within a few hundred feet of the wellhead. Although in most cases there is no gas content in the waterflow, in these water depths a stream of gas bubbles may form frozen gas hydrates at the sea bottom and on flat surfaces of seafloor drilling equipment. Shallow waterflows can result from buried channels filled with more permeable sediment. Abnormally pressured shallow sands may result from either rapid slumping or rotating faults or from reworked cut-and-fill channels sealed by impermeable mud or clay. In rare cases, hydrates below the mudline could be a source of shallow waterflow by melting down hydrates during oil production. Shallow waterflow events can cause additional expenditure of time and money for the driller to maintain well control and can lead to drilling difficulty up to and including a decision to permanently plug and abandon the well. Unanticipated shallow hazards can lead to downhole pressure kicks that range from minor and controllable to significant and uncontrollable; up to and including a serious blowout condition.

3.1.1.9.3. New and Unusual Technology

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. This Agency prepared a programmatic EA to evaluate potential effects of deepwater technologies and operations (USDOI, MMS, 2000). As a supplement to the EA, this Agency prepared a series of technical papers that provides a profile of the different types of development and production structures that may be employed in the GOM deepwater (Regg et al., 2000). The EA and technical papers were used in the preparation of this EIS.

The operator must identify new or unusual technology (NUT) in exploration and development plans. Some of the technologies proposed for use by the operators are actually extended applications of existing technologies and interface with the environment in essentially the same way as well-known or conventional technologies. These technologies are reviewed by BOEM for alternative compliance or departures that may trigger additional environmental review. Some examples of new technologies that do not affect the environment differently and that are being deployed in the Gulfwide OCS Program are synthetic mooring lines, subsurface safety devices, and multiplex subsea controls.

Some new technologies differ in how they function or interface with the environment. These include equipment or procedures that have not been installed or used in Gulf of Mexico OCS waters. Having no operational history, they have not been assessed by BOEM through technical and environmental reviews. New technologies may be outside the framework established by BOEM regulations and, thus, their performance (safety, environmental protection, efficiency, etc.) has not been studied by BOEM. The degree to which these new technologies interface with the environment and the potential impacts that may result are considered in determining the level of NEPA review that would be initiated if an operator wishes to deploy it.

The BOEM has developed a NUT's matrix to help facilitate decisions on the appropriate level of engineering and environmental review needed for a proposed technology. Technologies will be added to the NUT's matrix as they emerge, and technologies will be removed as sufficient experience is gained in their implementation. From an environmental perspective, the matrix characterizes new technologies into three components: technologies that may affect the environment; technologies that do not interact with the environment any differently than "conventional" technologies; and technologies for which BOEM does not have sufficient information to determine its potential impacts to the environment. In this later case, BOEM will seek to gain the necessary information from operators or manufacturers regarding the technologies to make an appropriate determination on its potential effects on the environment.

Alternative Compliance and Departures: The BOEM's project-specific engineering safety review ensures that equipment proposed for use is designed to withstand the operational and environmental condition in which it would operate. When an OCS operator proposes the use of technology or procedures not specifically addressed in established BOEM regulations, the operations are evaluated for alternative compliance or departure determination. Any new technologies or equipment that represent an alternative compliance or departure from existing BOEM regulation must be fully described and justified before it would be approved for use. For BOEM to grant alternative compliance or departure approval, the operator must demonstrate an equivalent or improved degree of protection as specified in 30 CFR 550.141. Comparative analysis with other approved systems, equipment, and procedures is one tool that BOEM uses to assess the adequacy of protection provided by alternative technology or operations. Actual operational experience is necessary with alternative compliance measures before BOEM would consider them as proven technology.

In addition to new and unusual technology for drilling, as a result of the DWH event, many technologies or applications were developed in attempting to stop the spill and cap the well. The NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," applies to operators conducting operations using subsea BOP's or surface BOP's on floating facilities. The BOEM will assess whether each lessee has submitted adequate information demonstrating that it has access to and can deploy surface and subsurface containment resources that would be adequate to promptly respond to a blowout or other loss of well control. Containment resources could consist of, but are not limited to, subsea containment and capture equipment including containment domes and capping stacks, subsea utility equipment including hydraulic power, hydrate control, and dispersion injection equipment.

3.1.1.10. Decommissioning and Removal Operations

During exploration, development, and production operations, the seafloor around activity sites within a proposed lease sale area becomes the repository of temporary and permanent equipment and structures. In compliance with Section 22 of this Agency's Oil and Gas Lease Form (MMS-2005) and OCSLA regulations (30 CFR 250.1710—wellheads/casings and 30 CFR 250.1725—platforms and other facilities), lessees are required to remove all seafloor obstructions from their leases within 1 year of lease termination or relinquishment. These regulations require lessees to sever bottom-founded structures and their related components at least 5 m (15 ft) below the mudline to ensure that nothing would be exposed that could interfere with future lessees and other activities in the area. The structures are generally grouped into two main categories depending upon their relationship to the platform/facilities (piles, jackets, caissons, templates, mooring devises, etc.) or the well (i.e., wellheads, casings, casing stubs, etc.).

There are possible exemptions to the one-year deadline, including the exemptions stated in Section 388 of the EPAct. Section 388 clarifies the Secretary's authority to allow an offshore oil and gas structure, previously permitted under the OCSLA, to remain in place after oil and gas activities have ceased in order to allow the use of the structure for other energy and marine-related activities. This authority provides opportunities to extend the life of facilities for non-oil and gas purposes, such as research, renewable energy production, aquaculture, etc., before being removed.

A varied assortment of severing devices and methodologies has been designed to cut structural targets during the course of decommissioning activities. These devices are generally grouped and classified as either nonexplosive or explosive, and they can be deployed and operated by divers, ROV's, or from the surface. Which severing tool the operators and contractors use takes into consideration the target size and type, water depth, economics, environmental concerns, tool availability, and weather conditions.

Nonexplosive severing tools are used on the OCS for a wide array of structure and well decommissioning targets in all water depths. Based on 10 years of historical data (1994-2003), nonexplosive severing is employed exclusively on about 58 (~37%) removals per year (USDOI, MMS, 2005). Since many decommissionings use both explosive and nonexplosive technologies (prearranged or as a backup method), the number of instances may be much greater. Common nonexplosive severing tools consist of abrasive cutters (e.g., sand cutters and abrasive water jets), mechanical (carbide) cutters, diver cutting (e.g., underwater arc cutters and the oxyacetylene/oxy-hydrogen torches), and diamond wire cutters.

With the exception of minor air and water quality concerns (i.e., exhaust from support equipment and toxicity of abrasive materials), nonexplosive severing tools generally cause little to no environmental impacts; therefore, there are very few regulations regarding their use. However, the use of nonexplosive cutters leads to greater human health and safety concerns, primarily because (1) divers are often required in the methodology (e.g., torch/underwater arc cutting and external tool installation and monitoring), (2) more personnel are required to operate them (increasing their risks of injury in the offshore environment), (3) lower success rates require that additional cutting attempts be made, and (4) the cutters can only sever one target at a time; taking on average 30 minutes to several hours for a complete cut (USDOI, MMS, 2005). The last two items are often hard to quantify and assign risks to the cutters, but the main principle is that there is a linear relationship between the length of time any offshore operation is staged and on-site (exposure time) and the potential for an accident to occur (Twachtman Snyder & Byrd, Inc. and Louisiana State University, Center for Energy Studies, 2004). Therefore, even if there are no direct injuries or incidents involving a diver or severing technicians, the increased "exposure time" needed to successfully sever all necessary targets could result in unrelated accidents involving other barge/vessel personnel.

Explosive severance tools can be deployed on almost all structural and well targets in all water depths. Historically, explosive charges are used in about 98 (~63%) decommissioning operations annually (USDOI, MMS, 2005), often as a back-up cutter when other methodologies prove unsuccessful. Explosives work to sever their targets by using (1) mechanical distortion (ripping), (2) high-velocity jet cutting, and (3) fracturing or "spalling."

Mechanical distortion is best exhibited with the use of explosives such as standard and configured bulk charges. If the situation calls for minimal distortion and an extremely clean severing, most contractors rely upon the jet-cutting capabilities of shaped charges. In order to "cut" with these explosives, the specialized charges are designed to use the high-velocity forces released at detonation to transform a metal liner (often copper) into a thin jet that slices through its target. The least used method of severing currently in use on the Gulf of Mexico OCS is fracturing, which uses a specialized charge to focus pressure waves into the target wall and use refraction forces to spall or fracture the steel on the opposing side (NRC, 1996).

This Agency first addressed removal operations and the potential impacts of severing methodologies (nonexplosive/explosive tools) in a programmatic EA prepared in 1987 (USDOI, MMS, 1987). The scope of the decommissioning activities analyzed in the document was limited to traditional, bottom-founded structures (i.e., well protectors, caissons, and jacketed platforms) and did not address well abandonment operations; activities similar in nature, but monitored and reported according to a separate section of the OCSLA regulations. In addition, since the majority of removal operations took place in water depths less than 200 m (656 ft), only the shelf areas of the CPA/WPA were addressed by the proposed actions.

In 1988, this Agency requested a "generic" consultation from NMFS pursuant to Section 7 of the Endangered Species Act concerning potential impacts on endangered and threatened species associated with explosive-severance activities conducted during structure-removal operations. Much like the Programmatic EA, the consultation's "generic" Biological Opinion (BiO) was limited to the best scientific information available and concentrated primarily on the majority of structure removals (water depths <200 m [656 ft]). The Incidental Take Statement (ITS) was therefore limited to the five species of sea turtle found on the shallow shelf. Reporting guidelines and specific mitigation measures are outlined in the ITS and include (1) the use of a qualified NMFS observer, (2) aerial surveys, (3) detonation delay radii, (4) nighttime blast restrictions, (5) charge staggering and grouping, and (6) possible diver survey requirements.

Emphasizing a continued need for an incentive to keep explosive weights low, this Agency formally requested that NMFS amend the 1988 BiO to establish a minimum charge size of 5 lb. The NMFS's Southeast Regional Office subsequently addressed explosive charges ≤5 lb in a separate, informal BiO. The October 2003 "de-minimus" BiO waives several mitigating measures of the "generic" 1988 BiO (i.e., aerial observations, 48-hour predetonation observer coverage, onsite NOAA personnel, etc.), reduces the potential impact zone from 3,000 ft to 700 ft (914 m to 213 m) and gives the operators/severing contractors the opportunity to conduct their own observation work.

In 1989, API petitioned NMFS under Subpart A of the Marine Mammal Protection Act regulations for the incidental take of spotted and bottlenose dolphins during structure-removal operations (i.e., for either explosive- or nonexplosive-severance activities). The Incidental Take Authorization regulations were promulgated by NMFS in October 1995 (60 FR 53139, October 12, 1995) and on April 10, 1996 (61 FR 15884), the regulations were moved to Subpart M (50 CFR 216.141 et seq.). Effective for 5 years, the regulations detailed conditions, reporting requirements, and mitigating measures similar to those listed in the 1988 ESA Consultation requirements for sea turtles. After the regulations expired in November 2000, NMFS and this Agency advised operators to continue following the guidelines and mitigating measures of the lapsed subpart pending a new petition and subsequent regulations. At industry's prompting, NMFS released Interim regulations in August 2002, which expired on February 2, 2004. Operators have continued to follow the Interim conditions until NMFS promulgates new regulations.

This Agency prepared a Programmatic EA, *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf* (USDOI, MMS, 2005), to evaluate the full range of potential environmental impacts of structure-removal activities in all water depths in the CPA and WPA and the Sale 181/189 area in the EPA of the GOM. The activities analyzed in the Programmatic EA include vessel and equipment mobilization, structure preparation, nonexplosive- and explosive-severance activities, post-severance lifting and salvage, and site-clearance verification. The impact-producing factors of structure removals considered in the Programmatic EA include seafloor disturbances, air emissions and water discharges, pressure and acoustic energy from explosive detonations, and space-use conflicts with other OCS users. No potentially significant impacts were identified for air and water quality; marine mammals and sea turtles; fish, benthic, and archaeological resources; or other OCS pipeline, navigation, and military uses. On the basis of this Programmatic EA, this Agency determined that an EIS was not required and prepared a Finding of No Significant Impact.

In water depths >800 m (2,625 ft), OCS regulations would offer the lessees the option to avoid the jetting by requesting alternate removal depths for well abandonments (30 CFR 250.1716(b)(3)) and facilities (30 CFR 250.1728(b)(3)). Above mudline cuts would be allowed with reporting requirements on the remnant's description and height off of the seafloor to BOEM—data necessary for subsequent reporting to the U.S. Navy. In some cases, industry has indicated that it could use the alternate removal depth options, coupled with quick-disconnect equipment (i.e., detachable risers, mooring disconnect systems, etc.) to fully abandon in-place wellheads, casings, and other minor, subsea equipment in deep water without the need for any severing devices.

After bottom-founded objects are severed and the structures are removed, operators are required to verify that the site is clear of any obstructions that may conflict with other uses of the OCS. The NTL 98-26, "Minimum Interim Requirements for Site Clearance (and Verification) of Abandoned Oil and

Gas Structures in the GOM," provides the requirements for site clearance. The lessee must develop, and submit to the BOEM for approval, a procedural plan for the site clearance verification procedures. For platform and caisson locations in water depths of <91 m (300 ft), the sites must be trawled over 100 percent of the designated area in two directions (i.e., N-S and E-W). Individual well-site clearances may use high-frequency (500 kHz) sonar searches for verification. Site-clearance verification must take place within 60 days after structure-removal operations have been conducted.

WPA and CPA Proposed Action Scenarios: **Tables 3-2 and 3-3** show platform removals by water-depth subarea as a result of the proposed actions. Of the 14-22 production structures estimated to be removed as a result of a WPA proposed action, 7-13 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives. Of the 32-61 production structures estimated to be removed as a result of a CPA proposed action, 20-40 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives. It is anticipated that multiple appurtenances will not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft). An estimate of the well stubs and other various subsea structures that may be removed using explosives is not possible at this time.

OCS Program Scenario: **Tables 3-4, 3-5, and 3-6** show platform removals by water-depth subarea for the total OCS Program and by planning area. Of the 233-350 production structures estimated to be removed from the WPA during 2012-2051, 160-241 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives. Of the 1,046-1,485 production structures estimated to be removed from the CPA during 2012-2051, 988-1,406 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives.

Note that offshore and onshore impact producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA, will be disclosed in a subsequent EIS.

3.1.2. Coastal Impact-Producing Factors and Scenario

3.1.2.1. Coastal Infrastructure

The following sections discuss coastal impact-producing factors and provide scenario projections for onshore coastal infrastructure that may potentially result from a single WPA or CPA proposed action in the 2012-2017 5-Year Program. This discussion describes the potential need for new facility construction and expansions of existing ones. Detailed descriptions of the baseline affected environment for land use and coastal infrastructure in the WPA and CPA are provided in **Chapters 4.1.1.1.20.1.1 and 4.2.1.1.23.1.1,** respectively.

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. The oil and gas industry supports thousands of jobs; its direct and indirect economic impacts ripple through the Gulf Coast economy. The OCS related infrastructure is a longstanding feature of these regional economies. This infrastructure has been developed over many decades, and it is an extensive and mature system that provides support for offshore activities.

The extensive presence of this coastal infrastructure is the result of long-term industry trends. Its presence is not subject to rapid fluctuations. In this context, the potential for new facilities and expansion at existing facilities depends foremost on the OCS activity levels, which have been somewhat depressed since the DWH event and the subsequent drilling suspensions. The scenario projections outlined below reflect the already well-established industrial infrastructure in the GOM regions and reduced OCS activity levels.

Chapter 4.1 addresses incomplete or unavailable information, including that related to or as a result of the DWH event. Infrastructure projections reflect long-term industry trends, and any changes to these trends that might be due to the DWH event cannot be determined from the limited post-DWH data available at the time this EIS was prepared. However, any changes that do occur are likely to be temporary, and the data that are available indicate that any DWH effects will most likely temporarily reduce the level of industry activity.

The BOEM makes conservative infrastructure scenario estimates; a projection of between 0 and 1 is more likely to be 0 than 1. These scenario estimates have become more conservative in the aftermath of the DWH event. The BOEM will continue to collect new data and to monitor changes in infrastructure demands in order to support scenario projections that reflect current and future industry conditions.

The coastal impacting factors most likely to affect the analysis areas include construction of (1) service bases, (2) gas processing plants, (3) coastal pipelines and pipeline landfalls, (4) navigation channels, and (5) waste disposal facilities for offshore operations. Existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. Should there be some expansion at current facilities, the land in the analysis area is sufficient to handle such development. While no proposed action is projected to significantly change existing OCS-related service bases or require any additional service bases, a proposed action would contribute to the use of existing service bases. Sufficient land exists 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 life of a proposed action. The majority of new pipelines constructed as a result of a proposed action would connect to the existing offshore pipeline infrastructure (Dismukes, official communication, 2011a). Therefore, BOEM projects 0-1 pipeline landfalls as a result of a proposed action. As industry responds to the post-DWH event environment with increased scrutiny of industry practices and regulatory revisions, the 0-1 projection range becomes more conservative, i.e., it becomes even more likely that the number would be zero (Dismukes, official communication, 2011a). While a proposed action would contribute to the continued need for maintenance dredging of existing navigation channels, a mature network of navigation channels already exists in the analysis area; therefore, no new navigation channel construction would be expected as a direct result of a proposed action. Existing solid-waste disposal infrastructure is adequate to support both existing and projected offshore oil and gas drilling and production needs. The BOEM analyses indicate that there is an abundance of solid-waste capacity in the GOM region and, thus, it is highly unlikely that any new waste facilities would be constructed. Recent research shows that the volume of OCS waste generated is closely correlated with the level of offshore drilling and production. In the months following the DWH event, activity levels have decreased, and it is unclear how long this trend will continue. Therefore, BOEM is not projecting any new waste facilities as a result of a proposed action.

The following sections provide the current trends and outlook for the varied infrastructure categories. With the exception of those discussed above, they are expected to maintain current levels.

The primary sources for the information on coastal infrastructure and activities presented here are BOEM's 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, in press); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* and *Volume II: Communities in the Gulf of Mexico* (Dismukes, in preparation and Kaplan et al., in preparation, respectively). Within the last 5 years, this Agency analyzed historical data and validated past scenario projections of new pipeline landfalls and new onshore waste disposal sites (USDOI, MMS, 2007a and 2007b).

3.1.2.1.1. Service Bases

The proposed actions are expected to impact only those ports that currently have facilities used by the oil and gas industry as offshore 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. Although a service base may primarily serve the OCS planning area and EIA's in which it is located, it may also provide significant services for the other OCS planning areas and EIA's. **Table 3-15** shows the 50 services bases the OCS currently uses. These facilities were identified as the primary service bases by platform plans received by BOEM. The ports of Fourchon, Cameron, Venice, and Morgan City, Louisiana, are the primary service bases for GOM mobile rigs. Major platform service bases are Galveston, Freeport, and Port O'Connor, Texas; Cameron, Fourchon, Intracoastal City, Morgan City, and Venice, Louisiana; Pascagoula, Mississippi; and Theodore, Alabama.

As the industry continues to evolve, so do the requirements of the onshore support network. With advancements in technology, the shore-side supply network will continue to be challenged to meet the needs and requirements. All supplies must be transported from land-based facilities to marine vessels or helicopters to reach offshore destinations: a switch from land to water and air transportation modes. The intermodal nature of these operations gives ports (which traditionally have water, rail, and highway access) a natural advantage as ideal locations for onshore activities and intermodal transfers. Therefore, ports will continue to be a vital factor in the total process and must incorporate the needs of the offshore oil and gas industry into their planning and development efforts particularly with regard to determining their future investment needs. In this manner, both technical and economic determinants influence the dynamics of port development.

Rapidly developing technology has resulted in changing needs for the offshore oil and gas industry. This has placed a burden on the ports to provide the necessary infrastructure and support facilities required to meet the needs of the industry in a timely manner. To continue to offer a viable service and to stay current with technological trends and industry standards, ports must be able to incorporate offshore oil and gas industry information into their planning for future infrastructure development, staffing needs, and other impacts associated with industrial growth.

Expansion of some existing service bases is expected to occur to capture and accommodate the current and future oil and gas business that is generated by development on the OCS and State waters. Some channels in and around the service bases will be deepened and expanded in support of deeper draft vessels and other port activities, some of which will be OCS related. Channel depths at most major U.S. ports typically range from 35 to 45 ft (11 to 14 m). The current generation of new large ships that service the offshore industry requires channels from 45 to 53 ft (14 to 16 m).

As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range, faster speed, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation systems; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership.

Summary: A proposed action will not change identified service bases or require any additional service bases. The OCS activities over the course of the 5-Year Program will continue to lead to a consolidation of port activities at specific ports especially with respect to deepwater activities (i.e., Port Fourchon and Galveston). The OCS Program will require no additional service bases.

3.1.2.1.2. Helicopter Hubs

Helicopter hubs or “heliports” are facilities where helicopters can land, load, and offload passengers and supplies, refuel, and be serviced. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Most of the helicopter operations originate at helicopter hubs in coastal Texas and Louisiana. There are 241 identified heliports within the Gulf region that support OCS activities; 118 are located in Texas, 115 in Louisiana, 0 in Florida, 4 in Mississippi, and 4 in Alabama. Industry consolidation has resulted in a small number of large helicopter service providers. The Gulf is served primarily by three large operators, which account for nearly 80 percent of the aircraft available in the Gulf. **Figure 3-6** shows the locations of the major helicopter service providers. A few major oil companies operate and maintain their own fleets, although this is a decreasing trend since oil and gas companies are increasingly subcontracting the whole operation to independent contractors. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed (Dismukes, in preparation).

This industry is largely dependent on the level of production, development, and exploration in the Gulf. 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. Helicopters must have the capability of traversing longer distances with more cargoes than were necessary in the past. Also, new technologies may permit companies to reduce staffing levels on both old and new installations, which could translate into less demand for helicopter.

Summary: Helicopter operations projected for a WPA proposed action are 290,000-605,000 round-trip operations (**Table 3-2**). A CPA proposed action is projected to generate 696,000-1,815,000 helicopter operations (**Table 3-3**). No new heliports are projected as a result of the OCS Program; however, if activity levels increase, they may expand at current locations. The projected number of helicopter operations for the OCS Program is 28,710,000-55,605,000 operations over the 2012-2051 period (**Table 3-4**). This equates to an average rate of 717,750-1,390,125 operations annually.

3.1.2.1.3. Construction Facilities

3.1.2.1.3.1. Platform Fabrication Yards

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe platform fabrication yards in the analysis areas. Platform fabrication is highly dependent on the structural nature of the oil and gas industry. As oil prices fluctuate, platform fabrication yards adjust accordingly. When oil prices are low, they have to diversify their operations into other marine-related activities or scale back on the overall scope of their operations. The variety of diversification strategies may include drilling rig maintenance and re-builds, barge or vessel fabrication, dry-docking, and equipment survey.

The existing fabrication yards do not operate as “stand alone” businesses, rather they rely heavily on a dense network of suppliers of products and services. Also, since such a network has been historically evolving in Louisiana and Texas for many decades, the existing fabrication yards possess a compelling force of economic concentration to prevent the emergence of new fabrication yards. There are 54 platform fabrication yards in the analysis area, with the highest concentration in Louisiana at 37, followed by Texas at 12.

With respect to the deepwater development, the challenges for the fabrication industry stem from the greater technical sophistication and the increased project complexity of the deepwater structures, such as compliant towers and floating structures. Deepwater projects are necessarily larger, more sophisticated, and costly, which results in two important trends for the fabrication industry. First, there is a greater degree of industry consolidation, at least with respect to the deepwater projects. Second, there is closer integration—through alliances, special project relationships, and joint ventures—among the fabrication yards and engineering firms. As technical and organizational challenges continue to mount up, it is expected that not every fabrication yard will find adequate resources to keep pace with the demands of the oil and gas industry.

Summary: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action. No new facilities are expected to be constructed in support of OCS Program activities. Some current yards may close, be bought out, or merge over the 2012-2051 period, resulting in fewer active yards in the analysis area. This may be even more likely given the reduction in drilling activity post-DWH.

3.1.2.1.3.2. Shipbuilding and Shipyards

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe shipbuilding and shipyards in the analysis areas. The shipbuilding and repair industry has struggled over the last few decades. Since the mid-1990’s, there has been some industry stabilization, but the outlook for shipbuilding and shipyards is uncertain. The industry is overly dependent on military contracts and faces numerous economic challenges, such as lack of international competitiveness, workforce development challenges, availability of capital, and the lack of research and development funding. In the GOM region, there is a direct correlation between oil and gas activities and the demand or opportunities for expanding shipbuilding and offshore support vessels (OSV’s). There are 137 shipyards located within the analysis areas (**Table 3-13**). Several large companies dominate the oil and gas shipbuilding industry. Most yards in the analysis areas are small. To a great extent, growth will be based on a successful resolution of several pertinent issues that have affected and will continue to affect shipbuilding in the U.S. and particularly in the analysis areas: maritime policy, declining military budget, foreign subsidies, USCG regulations, OPA 90, financing, and an aging fleet.

Generally, as oil and gas drilling and production increase, the demand for an expanded shipbuilding effort also increases. The temporary suspension of drilling in the GOM and the current reduced rate of permit approvals (compared with pre-DWH) has temporarily decreased activity in the GOM and has created a level of uncertainty with regard to future prospects in the industry. The BOEM expects that as activity levels gradually return to pre-DWH levels, the prospects for shipbuilding and shipyards should improve.

Summary: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action. There is more than an adequate supply of shipyard resources in the GOM. No new facilities are expected to be constructed in support of OCS Program activities. Some shipyards may close, be bought out, or merge over the 2012-2051 period, resulting in fewer active yards in the analysis area.

3.1.2.1.3.3. Pipecoating Facilities and Yards

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe pipecoating facilities and yards in the analysis areas. There are currently 19 pipecoating plants in the analysis areas (**Table 3-13**). Pipecoating facilities receive manufactured pipe, which they then coat the surfaces of with metallic, inorganic, and organic materials to protect from corrosion and abrasion and to add weight to counteract the water's buoyancy. Two to four sections of pipe are then welded at the plant into 40-ft (12-m) segments. The coated pipe is stored (stacked) at the pipeyard until it is needed offshore.

To meet deepwater demand, pipecoating companies were expanding capacity or building new plants. In the few months after the DWH event, activity levels dropped temporarily. As activity increases in the GOM post-DWH, the demands for pipecoating services will increase, but these would most likely be met by expansions at existing facilities.

Summary: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action. Current capacity, supplemented by expansions at already existing facilities, is anticipated to meet OCS Program demand. No new facilities are expected to be constructed in support of OCS Program activities.

3.1.2.1.4. Processing Facilities

3.1.2.1.4.1. Refineries

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe refineries in the analysis areas. Most of the region's refineries are located in Texas and Louisiana (**Table 3-13**). Texas has 26 operable refineries, with a total capacity of 4.7 million barrels per day, representing almost 27 percent of U.S. operable refining capacity. Louisiana has 18 operable refineries, with a total capacity of over 3 million barrels per day, representing 18 percent of U.S. operable refining (USDOE, Energy Information Administration, 2011b).

Distillation capacity is projected to range from the 2008 year-end level of 17.6 million barrels per day to 16.0 million barrels per day in 2025 and 15.8 million barrels per day in 2035. After the 2008 economic downturn, demand for petroleum products declined; however, new refining capacity that was planned before the downturn will come on line despite lower utilization levels. The Energy Information Administration estimates this new refining capacity contributes an additional 400,000 bbl per day of new distillation capacity at the end of 2012. Refinery expansions have been focused on diesel output with new configurations to process heavier crudes. After 2013, no additional capacity expansions are expected, thus the decline in projected refining capacity from 2013 to 2035 (USDOE, Energy Information Administration, 2011c).

Summary: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action. For many years financial, environmental, and legal considerations have made it unlikely that new refineries will be built in the United States, and this is expected to continue. Therefore, expansion at existing refineries likely will eventually increase total U.S. refining capacity over the 2012-2051period.

3.1.2.1.4.2. Gas Processing Plants

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe gas processing plants in the analysis areas. As of July 1, 2011, there were 94 OCS-related gas processing plants in the BOEM-identified 13 EIA's along the Gulf Coast. The vast majority of gas processing plants are located in Louisiana (44) and Texas (39), followed by Alabama (13), Mississippi (1) and Florida (1) (**Table 3-13).**

There has been a substantial decrease in offshore natural gas production, partially a result of increasing emphasis on onshore shale gas development, which is less expensive to produce, closer to consumption sources, and provides larger per well production opportunities and reserve growth (average annual growth rate of 48% over the 2006-2010 period) (USDOE, Energy Information Administration, 2011c). Also, there has been a trend toward more efficient gas processing facilities with greater processing capacities (Dismukes, official communication, 2011a). For example, in Texas the average daily processing capacity per plant has increased from 66 MMcf to 95 MMcf between 1995 and 2004 (USDOE, Energy Information Administration, 2006, p. 6). While natural gas production on the OCS shelf (shallow water) has been rapidly declining, deepwater gas production has been increasing, but not 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. The existing facilities that were only 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 life of a proposed action (Dismukes, official communication, 2011a).

It is likely that a large share of the natural gas processing capacity that is needed in the industry will be located at existing facilities, using future investments for expansions and/or to replace depreciated capital equipment for a variety of reasons. The reasons for this include lower development costs because of existing structures and utility services; existing interconnections to pipelines, natural gas liquid lines, and fractionators; incremental labor requirements are low relative to new facility staffing; the advantages of existing support, logistical and supply relationships such a vendors and maintenance support; and general economies of scale (Dismukes, official communication, 2011b).

Summary: The BOEM projects that 0-1 new gas processing facility may be constructed as a result of a WPA or CPA proposed action. However, the likelihood of a new gas processing facility has moved closer to zero and farther from one (Dismukes, official communication, 2011a). 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 predicable over the next 40 years.

3.1.2.1.4.3. Liquefied Natural Gas Facilities

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe liquefied natural gas (LNG) facilities in the analysis areas. The GOM area has a wide variety of pipeline systems and delivery markets that make it attractive to LNG developers. Also, the GOM has some of the largest refinery, petrochemical, and paper-pulp facilities in the worlds, all of which either consume large quantities of natural gas for production purposed or transform natural gas into high quality fuels or products. From 2002 until 2007, there was a sharp increase in the amount of U.S. natural gas imports as a percent of total consumption. There were several terminal expansions in the 2006-2007 timeframe. Since 2008, there has been a sharp decrease in the amount of natural gas imported to the U.S. and announcements for new regasification facilities along the coast. The United States' imports of natural gas are expected to continue to decline. Onshore natural gas production has increased to the extent that LNG facilities along the GOM are seeking and getting approval to export natural gas to foreign countries. Offshore natural gas production has been declining, and this trend is expected to continue (Dismukes, official communication 2011c).

Summary: The BOEM projects that expansions at existing facilities and construction of new facilities would not occur as a direct result of a WPA or CPA proposed action or the OCS Program. Any expansions or new facilities would be the result of onshore, rather than offshore, production.

3.1.2.1.5. Terminals

3.1.2.1.5.1. Pipeline Shore Facilities

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe pipeline shore facilities in the analysis areas. 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. Some processing may occur offshore at the platform; only onshore facilities are addressed in this discussion. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to the gas processing plant. Therefore, new pipeline shore facilities are projected to only result from oil pipeline landfalls. A pipeline shore facility may support one or several pipelines; therefore, new pipeline shore facilities are projected to only result from larger pipelines (>12 in; 30 cm). Although older facilities may be located in wetlands, current permitting programs prohibit or discourage companies from constructing any new facilities in wetlands. Also, it is more cost effective for companies to tie into the existing offshore pipeline network.

Summary: No new pipeline shore facilities are projected as a result of a WPA or CPA proposed action. It is projected that a proposed action would represent a small percent of the resources handled by existing and projected shore facilities. As a result of the OCS Program, there may be a need in some rare instance for new shore facilities to support new larger oil pipeline landfalls, but this is not likely.

3.1.2.1.5.2. Barge Terminals

Barging of OCS production is expected to remain stable. No major modifications or new barge terminals are expected to be constructed in the foreseeable future to support proposed-action or OCS-Program operations.

3.1.2.1.5.3. Tanker Port Areas

The transport of OCS-produced oil from floating production, storage, and offloading (FPSO) operations to inside or shore-side facilities would be accomplished with shuttle tankers rather than oil pipelines. The following tanker ports were identified as destinations for shuttle tankers transporting crude oil from FPSO operations in the GOM: Houston or the LOOP are most likely candidates, followed by possibly Corpus Christi, Freeport, and Port Arthur/Beaumont, Texas; although it would be most likely for oil to be transported to Port Arthur/Beaumont via pipeline (Dismukes, official communication, 2011d).

The number of shuttle-tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000-bbl capacity, offloading would occur once every 3.3 days. This would equate to 54.75 MMbbl of production with 110 offloading events and shuttle-tanker transits to Gulf coastal or offshore ports annually per FPSO.

Summary: Up to 330 offloading operations and shuttle tanker transits are estimated to occur annually during the peak years of FPSO use as a result of a WPA or CPA proposed action. Tanker trips associated with a proposed action's activities would represent a small percentage of annual tanker trips into identified tanker ports. Up to 792 offloading operations and shuttle tanker transits would occur annually during the peak years of FPSO use as a result of the OCS Program. Tanker trips associated with the OCS Program activities would represent a small percentage of annual tanker trips into identified tanker ports.

3.1.2.1.6. Coastal Pipelines

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe coastal pipelines in the analysis areas. The OCS pipelines nearshore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland.

The long-term trend since the mid-1980's is for new OCS pipelines to tie into existing systems rather than creating new landfalls. Since 1986, the 5-year moving average of new OCS pipeline landfalls has been below two per year. Over the last 15 years (1996-2011), there has been an average of slightly over one new OCS pipeline landfall per year (1.25). **Table 3-16** lists the OCS pipeline landfalls that have been installed since 1996. To project the likely number of new OCS pipeline landfalls, BOEM examined the historical relationships between new pipeline landfalls and a variety of factors including platforms installed, oil and gas production, and the total number of new pipelines. Based on this examination, BOEM assumes that the majority of new Federal OCS pipelines would connect to the existing pipelines in Federal and State waters and that very few would result in new pipeline landfalls. Therefore, this Agency projects 0-1 pipeline landfalls per lease sale (USDOI, MMS, 2007a).

Oil and gas companies have a strong financial incentive to reduce costs by utilizing, to the fullest extent possible, the mature pipeline network that already exists in the GOM. Economies of scale are a factor in pipeline transportation; maximizing the amount of product moved through an already existing pipeline decreases the long-term average cost of production. Additional considerations include mitigation costs for any new wetland and environmental impacts and various landowner issues at the landfall point.

Because of these strong incentives to move new production into existing systems and to avoid creating new landfalls, BOEM projects that the majority of new pipelines constructed as a result of a proposed action would connect to the existing pipeline infrastructure. In the rare instance that a new pipeline would need to be constructed, it will likely be because there are no existing pipelines reasonably close and because constructing a pipeline to shore is considered more cost effective; although it is highly unlikely for an operator to choose this contingency (Dismukes, official communication, 2011a).

Summary: The BOEM projects that 0-1 new landfalls may occur for a WPA or CPA proposed action, although the likelihood of a new pipeline landfall has moved closer to zero and farther from one (Dismukes, official communication, 2011a). The OCS Program may result in up to 12 new landfalls.

3.1.2.1.7. Coastal Barging

It is projected that OCS oil barged from offshore platforms to onshore barge terminals will continue to represent a small portion of the total amount of oil barged in coastal waters. There is a tremendous amount of barging that occurs in the coastal waters of the GOM, and no estimates exist of the volume of this barging 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.

The current rate of OCS barging is expected to continue and is not likely to make up a significantly larger percentage of the total oil barged than what is currently occurring.

3.1.2.1.8. Navigation Channels

Navigation channels undergo maintenance dredging that is essential for sustaining proper water depths to allow ships to move safely through the waterways to ports, services bases, and terminal facilities. In the northern GOM, the existing system of navigation channels is projected to be adequate to allow proper accommodation for vessel traffic that will occur as a result of a single WPA or CPA proposed action. The Gulf-to-port channels and the Gulf Intracoastal Waterway (GIWW) that support prospective OCS ports are maintained by regular dredging and are generally sufficiently deep and wide to handle OCS-related traffic (**Figure 3-7**). The COE is the Federal agency responsible for the regulation and oversight of navigable waterways. The maintained depth for each waterway is shown in **Table 3-14**. All single lease sales contribute to the level of demand for offshore supply vessel support; hence, they also contribute to the level of vessel traffic that travels through the navigation channels to support facilities. While maintenance dredging is essential for vessels to safely reach support facilities, it is a controversial process because it necessarily occurs in or near environmentally sensitive resources such as valuable wetlands, estuaries, and fisheries. Also, as exploration and development activities increase on deepwater leases in the GOM, vessels with generally deeper drafts and longer ranges will be used as needed to support deepwater activities. Therefore, several OCS-related port channels may be deepened or widened during the life of a proposed action to accommodate deeper draft vessels.

Summary: A WPA or CPA proposed action would contribute to the continued need for maintenance dredging of existing navigation channels. However, no additional maintenance dredging is expected to be scheduled or new navigation channels are expected to be constructed as a direct result. There is no current expectation for new navigation channels to be authorized and constructed during the years 2012-2051 as a direct result of the OCS Program. One major Federal channel, the Mississippi River Gulf Outlet, was taken out of service and sealed with a rock dike in 2009.

3.1.2.2. Discharges and Wastes

3.1.2.2.1. Disposal and Storage Facilities for Offshore Operational Wastes

Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1 describe coastal impacting factors arising from the infrastructure network needed to manage the spectrum of waste generated by OCS activity and disposal onshore in the GOM. The BOEM funded research by Dismukes et al. (2007) further supports past conclusions that existing solid-waste disposal infrastructure is adequate to support both existing and projected offshore oil and gas drilling and production needs. Recently, there is a trend toward incorporating more innovative methods for waste handling in an attempt to reduce the chance of adverse environmental impacts. Some of these innovative methods include 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 (Dismukes, in preparation).

Before the DWH event, this Agency's analyses indicated that there was an abundance of solid-waste capacity in the GOM region and, thus, it is highly unlikely that any new waste facilities would be constructed. Recent research shows that the volume of OCS waste generated is closely correlated with the level of offshore drilling and production activity. If offshore activities increase to the extent that a need for more capacity develops, it will probably be met by expansion of existing facilities. However, it is now unclear whether this will remain true; therefore, more research is needed (Dismukes, official communication, 2011a). Due to the temporary suspension (no longer in effect) on deepwater drilling, 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 temporary reduction in activity will continue or how long it will take for activity levels to recover. Since there is not enough information at this time to draw a solid conclusion, BOEM will continue to monitor waste disposal demands and activity in the post-DWH environment. **Chapter 4.1.1.20.4.2** provides a discussion of environmental justice issues related to waste disposal facilities.

Summary: For a WPA or CPA proposed action, existing onshore facilities would continue to be used to dispose of wastes generated offshore. However, no new disposal facilities are expected to be licensed as a direct result of a proposed action. There is no current expectation for new onshore waste disposal facilities to be authorized and constructed during the 2012-2051 period as a direct result of the OCS Program. If needed, existing facilities may undergo expansion, but no new disposal facilities are expected.

3.1.2.2.2. Onshore Facility Discharges

The primary onshore facilities that support offshore oil and gas activities include service bases, helicopter hubs at local ports/service bases, construction facilities (platform fabrication yards, pipeyards, shipyards), processing facilities (refineries, gas processing plants, petrochemical plants), and terminals (pipeline shore facilities, barge terminals, tanker port areas). Detailed descriptions of these facilities is given in **Chapters 4.1.1.20.1.1 and 4.2.1.23.1.1**. Water discharges from these facilities are from either point sources, such as a pipe outfall, or nonpoint sources, such as rainfall run-off from paved surfaces. The USEPA or the USEPA-authorized State program regulates point-source discharges as part of NPDES. Facilities are issued general or individual permits that limit discharges specific to the facility type and the waterbody receiving the discharge. Other wastes generated at these facilities are handled by local municipal and solid waste facilities, which are also regulated by USEPA or an USEPA-authorized State program.

3.1.2.2.3. Coastal Service-Vessel Discharges

Operational discharges from vessels include sanitary and domestic waters, bilge waters, and ballast waters. Support-vessel operators servicing the OCS offshore oil and gas industry may still legally discharge oily bilge waters in coastal waters, but they must treat the bilge water to limit its oil content to 15 ppm prior to discharge in accordance with both Annex 1 of the International Convention for the Prevention of Pollution from Ships (1973, as modified by the Protocol of 1978 [MARPOL]) and with the Act to Prevent Pollution from Ships. The Clean Water Act (CWA) prohibits the discharge of oil in harmful quantities that violate applicable water quality standards or that cause a visible sheen on the water. Sanitary wastes are treated on-board ships prior to discharge in accordance with Annex IV of MARPOL, 33 CFR 159, and 33 U.S.C. 1322 of the CWA. State and local governments regulate domestic or gray water discharges. Most WBF muds are disposed at the conclusion of a drilling job (Dismukes, in press). The WBF muds can be discharged 3 mi (5 km) or more from shore, following additional requirements through NPDES permits.

3.1.2.2.4. Offshore Wastes Disposed Onshore

Most wastes are not permitted to be discharged offshore by USEPA and must be transported to shore or reinjected downhole. Additionally, wastes may be disposed of onshore because they do not meet permit requirements or onshore disposal is economically advantageous. Wastes that are typically transported to shore include produced sand, aqueous fluids such as wash water from drilling and production operations, naturally occurring radioactive materials (NORM) such as tank bottoms and pipe scale, industrial wastes, municipal wastes, and other exploration and production wastes (Dismukes, in press). Most OBF muds and some SBF muds are recycled. If the physical and chemical properties of muds degrade, they may be disposed or treated and reused for purposes other than drilling, instead of being recycled. Different reuses of treated muds include, among others, fill material, daily cover material at landfills, aggregate or filler in concrete, and brick or block manufacturing. The OBF cuttings are disposed of onshore or are injected onsite (USEPA, 1999). Both USEPA Regions 4 and 6 permit the discharge of SBF wetted cuttings, provided the cuttings meet the criteria with regard to percent SBF retained, PAH content, biodegradability, and sediment toxicity. The SBF fluid is either recycled or transferred to shore for regeneration and reuse or disposal. Drill cuttings contaminated with hydrocarbons from the reservoir fluid must be disposed of onshore or reinjected.

The USEPA allows TWC fluids to be commingled with the produced-water stream if the combined produced-water/TWC discharges pass the toxicity test requirements of the NPDES permit. Facilities with less than 10 producing wells may not have enough produced water to be able to effectively commingle the TWC fluids with the produced-water stream to meet NPDES requirements (USEPA, 1993c). Spent TWC fluid is stored in tanks on tending workboats or is stored on platforms and later transported to shore on supply boats or workboats. Once onshore, the TWC wastes are transferred to commercial waste-treatment facilities and disposed in commercial disposal wells. Offshore wells are projected to generate an average volume of 200 bbl from either a well treatment or workover job every 4 years. Each new well completion would generate about 150 bbl of completion fluid.

Current U.S. Environmental Protection Agency NPDES general permits prohibit operators in the GOM from discharging any produced sands offshore. Cutting boxes (15- to 25-bbl capacities), 55-gallon steel drums, and cone-bottom portable tanks are used to transport the solids to shore via offshore service vessels. Total produced sand from a typical platform is estimated to be 0-35 bbl/day (USEPA, 1993c). Both Texas and Louisiana have State oversight of exploration and production waste management facilities (Veil, 1999).

3.1.2.2.5. Beach Trash and Debris

Marine debris originates from both land-based and ocean-based sources. Forty-nine percent of marine debris originates from land-based sources, 18 percent originates from ocean-based sources, and 33 percent originates from general sources (sources that are a combination of land-based and sea-based activities) (USEPA, 2009a). Some of the sources of land-based marine debris are beachgoers, storm-water runoff, landfills, solid waste, rivers, floating structures, and ill-maintained garbage bins. Marine debris also comes from combined sewer overflows and typically includes medical waste, street litter, and sewage. Ocean-based sources of marine debris include galley waste and other trash from ships, recreational boaters, fishermen, and offshore oil and gas exploration and production facilities. Commercial and recreational fishers produce trash and debris by discarding plastics (e.g., ropes, buoys, fishing line and nets, strapping bands, and sheeting), wood, and metal traps. Some trash items, such as glass, pieces of steel, and drums with chemical or chemical residues, can be a health threat to local water supplies, to beachfront residents, and to users of recreational beaches. To compound this problem, there is population influx along the coastal shorelines. These factors, combined with the growing demand for manufactured and packaged goods, have led to an increase in nonbiodegradable solid wastes in our waterways.

The discharge of marine debris by offshore oil and gas industry and supporting activities 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 USCG. The BOEM policy regarding marine debris prevention is outlined in NTL 2007-G03, "Marine Trash and Debris Awareness and Elimination" (USDOI, MMS, 2007c). 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 discharge of marine debris from OCS operations.

3.2. IMPACT-PRODUCING FACTORS AND SCENARIO—ACCIDENTAL EVENTS

3.2.1. Oil Spills

Oil spills are unplanned, accidental events but their frequency and volume can be estimated from past occurrences. The following sections discuss spill prevention and spill response, and analyze the risk of spills that could occur as a result of activities associated with a WPA or CPA proposed action. Public input through scoping meetings and Federal and State agencies' input through consultation and coordination indicate that oil spills are perceived to be a major issue, especially in the wake of the DWH event and resulting oil spill. The following section analyzes the risk of spills that could occur as a result of typical WPA or CPA proposed action, as well as information on the number and sizes of spills from non-OCS sources. In addition, **Appendix B** provides an analysis of the impacts of catastrophic spill events which are considered to be low in probability.

3.2.1.1. Spill Prevention

Beginning in the 1980's, this Agency established comprehensive pollution-prevention requirements that include redundant safety systems, as well as inspection and testing requirements to confirm that these devices are working properly (**Chapter 1.5).** Until the DWH event, an overall reduction in spill volume had occurred during the previous 40 years, while oil production had generally increased. A characterization of spill rates, average and median volumes from 1995 to 2009 compared with 1996-2010, which includes the DWH event, is provided in *Update of Oil Spill Occurrence Rates for Offshore Oil Spills* (USDOI, BOEMRE, 2011a). The BOEM attributes this improvement to BOEM's operational requirements, ongoing efforts by the oil and gas industry to enhance safety and pollution prevention, and the evolution and improvement of offshore technology.

3.2.1.2. Past OCS Spills

3.2.1.2.1. Coastal Spills

Spills occur in coastal waters at shoreline storage, processing, and transport facilities supporting the OCS oil and gas industry. Coastal spills occur in State offshore waters and in navigation channels, rivers, and bays from barges and pipelines carrying OCS-produced oil. These spills could be spills of crude oil or spills of fuel oil used in vessels. Many reports of spills cannot be traced back to the source or type of oil and are recorded as unknown. Similarly, for these small spills of unknown oil, the volume is also likely to be an estimate. Records of spills in coastal waters and State offshore waters are maintained by USCG (USDOT, CG, 2010a). The source is recorded, for example, as offshore pipeline, but the database does not identify the source of the oil in the pipeline (OCS versus non-OCS domestic). A pipeline carrying oil from a shore base to a refinery may be carrying oil from both State and OCS production; imported oil might also be commingled in the pipeline. The USCG also records the type of oil spilled and whether it is crude oil, a refined product such diesel fuel or a heavy fuel oil, or a type of commodity in transport, such as vegetable oil.

The BOEM pays special attention to spills related to exploration and production that occur on Federal leases in OCS waters; that is, the submerged lands, subsoil, and seabed lying between the seaward extent of the State's jurisdiction and the seaward extent of Federal jurisdiction. The BOEM does not maintain comprehensive data on spills that have occurred in the State's jurisdiction. However, in recent years, BOEM occasionally has collected information on State pollution incidents (USDOI, BOEMRE, 2010c). Therefore, there is no database available that contains all past spills that have occurred in State offshore or coastal waters directly as a result of OCS oil and gas development.

3.2.1.2.2. Offshore Spills

The BOEM spill-event database includes records of past spills from activities that BOEM regulates. These data include oil spills >1 bbl that occurred in Federal waters from OCS facilities and pipeline operations. Spills from facilities include spills from drilling rigs, drillships, and storage, processing, or production platforms that occurred during OCS drilling, development, and production operations. Spills from pipeline operations are those that have occurred on the OCS and are directly attributable to the transportation of OCS oil.

The most recent, published analysis of trends in OCS spills was used to project future spill risk for this EIS (USDOI, BOEMRE, 2011a). This report presents an analysis of the most recent 15 years of data (1996-2010 data) as well as the previous 15 years (1985-1999 data). Data for the most recent period reflect spill prevention and occurrence conditions. The 15-year record was chosen because it reflects how the spill rates have changed while still maintaining a significant portion of the record.

Tables 3-17 and 3-18 provide information on OCS oil and spills ≥1,000 bbl that have occurred offshore in the GOM for the entire period that records have been kept (1964-present). The BOEM data records do not include spills ≤1 bbl; these small spills are reported to the National Response Center and are documented in the USCG Marine Information for Safety and Law Enforcement (2001-present) or prior information systems. Also not included in the BOEM database are spills that have occurred in Federal waters from OCS barging operations and from other service vessels that support the OCS oil and gas industry. These data are included in the USCG record of all spills; however, the USCG database does not include the source of oil (OCS versus non-OCS) or in the case of spills from vessels, the type of vessel operations; such information is needed to determine if a particular spill occurred as a result of OCS operations.

3.2.1.3. Characteristics of OCS Oil

The physical and chemical properties of oil greatly affect its transport and fate. These physical and chemical properties determine the following: how oil will behave on the water surface (surface spills) or in the water column and sediments (subsea spills); the persistence of the slick on the water; the type and speed of weathering processes; the degree and mechanisms of toxicity; the effectiveness of containment and recovery equipment; and the ultimate fate of the spill residues. Crude oils are a natural mixture of hundreds of different compounds, with liquid hydrocarbons accounting for up to 98 percent of the total composition. The chemical composition of crude oil can vary significantly from different producing areas; thus, the exact composition of oil being produced in OCS waters varies throughout the Gulf.

The American Petroleum Industry (API) gravity is a measurement of the density of the oil. The API gravity is calculated from the specific gravity; the lower the specific gravity, the higher the API gravity and the lighter the oil will be. Based on API gravity, crude oil may be described as "light" (i.e., approximately 20°-50° API) or "heavy" (i.e., generally less than 20° API) (USDOI, MMS, 2006b). Density is one of the most important physical characteristics of crude oil. The density of oil determines whether it will sink or float, or whether it will collect sediment (heavier oils tend to collect sediment) and sink. As well, the density of oil is one of the key factors in predicting whether spilled oil will entrain water and form emulsions.

Extensive laboratory testing has been performed on various oils from the GOM to determine their physical and chemical characteristics. There are currently 39 different oils collected from the Gulf of Mexico (U.S. waters) in Environment Canada's (2011) oil properties database. For each of these oils, the details of their chemical composition include hydrocarbon groups (i.e., saturates, aromatics, resins, asphaltenes), volatile organic compounds (VOC's) (such as benzene, toluene, ethylbenzene, and xylene), sulfur content, biomarkers, and metals. Light sweet crude oil (such as from the DWH event) is preferred by refineries and is referred to as "sweet" because of its low sulfur content. The composition of oil will change substantially following release during an oil spill, due to weathering processes such as evaporation. The API gravities for the oils identified in the Environment Canada (2011) database range from 16.4° to 50.2°. This is similar to the range identified in an Agency-funded study of 22.8° to 58.6° API for data from 67 plays (Trudel et al., 2001). It is expected that a typical oil spilled as a result of an accident associated with a WPA or CPA proposed action would be within the range of 30°-35° API. The oil at the light end of the range would have little asphaltenes, would not emulsify, and would not form tarballs. The oil at the heavier end of the range, or enriched in heavy components after weathering, would more likely emulsify and form tarballs.

3.2.1.4. Overview of Spill Risk Analysis

There are many factors that BOEM evaluates to determine the risk of impact occurring from an oil spill. Estimated information includes likely spill sources, likely spill locations, likely spill sizes, the likelihood and frequency of occurrence for different size spills, timeframes for the persistence of spilled oil, volumes of oil removed due to weathering and cleanup, and the likelihood of transport by wind and waves resulting in contact to specified environmental features. This section of the EIS addresses the likelihood of spill occurrence, transportation of oil slicks by winds and waves, and the probability of an oil spill contacting sensitive environmental resources. Sensitivity of the environmental resources and potential effects are addressed in the analyses for the specific resources of concern (**Chapters 4.1 and 4.2**).

The BOEM uses data on past OCS production and spills, along with estimates of future production, to evaluate the risk of future spills. Data on the numbers, types, sizes, and other information on past spills were reviewed to develop the spill scenario for analysis in this EIS. The spill scenario provides (1) the set of assumptions for and estimates of future spills, (2) the rationale for the scenario assumptions and estimates, and (3) the type, frequency, quantity, and fate of the spilled oil for specific scenarios. The spill scenario accounts for spill response and cleanup activities and the estimated time that the spill remains floating on the water.

The BOEM uses a numerical model to calculate the likely trajectory of spills and analyzes the historical database to make other oil-spill projections. Estimates are based on historical spills and do not consider the effect of the recent retirement of older platforms and pipelines in preventing spills. A description of the trajectory model, called the OSRA (oil spill risk analysis) model, and its results are summarized in this EIS and are published in a separate report (Ji et al., in preparation). The OSRA model simulates thousands of spills launched throughout the Gulf of Mexico OCS and calculates the probability of these spills being transported and contacting specified environmental resources. The OSRA modeling results in a numerical expression of risk based on spill rates, projected oil production, and trajectory modeling. The OSRA modeling does not include the effects of weathering and thus provides a conservative estimate of risk assessment. A discussion of weathering based on past analyses will be included in the following sections.

The following discussion provides separate risk information for offshore spills ≥1,000 bbl, offshore spills <1,000 bbl, and coastal spills that may result from a WPA or CPA proposed action. Only spills ≥1,000 bbl are addressed using OSRA because smaller spills may not persist long enough to be simulated by trajectory modeling. Another consideration is that these large spills are likely to be identified and reported; therefore, these records are more comprehensive than those of smaller spills.

3.2.1.5. Risk Analysis for Offshore Spills ≥1,000 bbl

This section addresses the risk of spills ≥1,000 bbl that could occur from accidents associated with activities resulting from a WPA or CPA proposed action.

3.2.1.5.1. Estimated Number of Offshore Spills ≥1,000 bbl and Probability of Occurrence

The number of spills ≥1,000 bbl estimated to occur as a result of a proposed action is provided in **Table 3-12** The mean number of spills estimated for a WPA proposed action is <1 (mean equal to 0.13-0.23). The mean number of spills estimated for a CPA proposed action is ≤1 spill (mean equal to 0.52-1.0). The range of the mean number of spills reflects the range of oil production volume estimated as a result of a proposed action. The mean number of future spills ≥1,000 bbl is calculated by multiplying the spill rate for spills ≥1,000 bbl (1.13 spills/Bbbl) by the volume of oil estimated to be produced as a result of a proposed action. This spill rate is the sum of rates for OCS platforms (0.25 spills/Bbbl) and OCS pipelines (0.88 spills/Bbbl) based on historical data from 1996 to 2010 (USDOI, BOEMRE, 2011a).

Spill rates were calculated based on the assumption that spills occur in direct proportion to the volume of oil handled and are expressed as number of spills per billion barrels of oil handled (spills/BBO).

The probabilities were calculated of a particular number of offshore spills ≥1,000 bbl resulting from a proposed action during the 40-year analysis period, including for facility spills, pipeline spills, and total spills (**Tables 3-19 and 3-20)**. For a WPA proposed action, there is a 11-18 percent chance of one spill ≥1,000 bbl occurring, a 1-2 percent chance of two spills ≥1,000 bbl occurring, and a 12-20 percent chance of one or more spills ≥1,000 bbl occurring in the WPA. For a CPA proposed action, there is a 31-37 percent chance of one spill ≥1,000 bbl occurring, an 8-18 percent chance of two spills ≥1,000 bbl occurring, a 1-6 percent chance of three spills ≥1,000 bbl occurring, and a 0-1 percent chance of four spills ≥1,000 bbl occurring. Overall, there is a 41-62 percent chance of one or more spills ≥1,000 bbl occurring in the CPA.

A report by BOEM scientists provides more information on OCS spill-rate methodologies and trends (USDOI, BOEMRE, 2011a). A discussion of how the range of resource estimates was developed is provided in **Chapter 3.1.1.1**.

3.2.1.5.2. Most Likely Source of Offshore Spills ≥1,000 bbl

Tables 3-19 and 3-20 indicate the probabilities of one or more spills ≥1,000 bbl occurring from OCS facility or pipeline operations related to a proposed action. The most likely cause of a spill ≥1,000 bbl is a pipeline break at the seafloor, with seven of the nine spill events ≥1,000 bbl during 1996-2010 caused by pipeline damage (USDOI, BOEMRE, 2011a). The various circumstances responsible for pipeline breaks during this period included damage by an anchor, mudslide damage during a hurricane, a jack-up rig barge crushing the pipeline when it sat down on it, and microfractures from chronic contacts at a pipeline crossing where separators between the pipelines were missing.

3.2.1.5.3. Most Likely Size of an Offshore Spill ≥1,000 bbl

The median size of spills ≥1,000 bbl that occurred during 1996-2010 is 2,240 bbl. This size was calculated based on the nine spills (both platforms/rigs and pipelines) that occurred during this timeframe and included the DWH oil spill. Based on this median size, BOEM estimates that the most likely size of a spill ≥1,000 bbl from a proposed action would be 2,200 bbl (**Table 3-12**).

3.2.1.5.4. Fate of Offshore Spills ≥1,000 bbl

Persistence

The persistence of an offshore oil slick is strongly influenced by how rapidly it spreads and weathers and by the effectiveness of oil-spill response in removing the oil from the water surface. As part of the risk analysis of an offshore spill ≥1,000 bbl, BOEM estimated in past analyses the expected persistence time of a spill—specifically, how long it might last as a cohesive mass on the surface of the water, capable of being tracked and moved by winds and currents (USDOI, MMS, 2007d). Hypothetical analyses were performed for a simulated pipeline break spilling approximately twice as much oil as estimated for a current proposed action. Based on several scenarios implemented in the weathering model (e.g., variable season, oil type, and emulsification), BOEM estimated that the spill would dissipate from the water surface in approximately 2-10 days. Similarly, an OCS pipeline spill on September 29, 1998, of 8,212 bbl, for which a panel investigation report was available, contained overflight information of the oil spill that showed the spill persisted for 5 days on the surface (USDOI, MMS, 1999).

Spreading

The GOM oils having API gravities between 30^{o} and 35^{o} will float, except under turbulent mixing conditions such as during a large storm offshore. Once spilled, it is expected that some portion of GOM oils would rise and reach the surface of the open Gulf, depending on the depth of spill and whether a subsurface plume forms. On the sea surface, the oil would rapidly spread out on the water surface, forming a slick that is initially a few millimeters (mm) in thickness in the center and much thinner around the edges. The rate of spreading depends upon the viscosity of the spilled oil, whether or not the oil is released at the water surface or subsurface, and whether the spill is instantaneous or continuous for some period. The spilled oil would continue to spread until its thickest part is about 0.1 mm. Once it spreads thinner than 0.1 mm, the slick would begin to break up into small patches, forming a number of elongated slicks, with an even thinner sheen trailing behind each patch of oil.

Past BOEM analyses have estimated the thickness and areal extent of a typical oil slick for different times after a spill event. These model estimates depend on specifying such parameters as the properties and characteristics of the spilled oil, as well as a typical cleanup response. For a simulated pipeline break spilling of approximately twice as much oil as estimated for a current proposed action, the slick would attain its greatest surface area by 12 hours after the spill event. The maximum water surface area covered by such a slick would be between 200 and 350 ac (81 and 142 ha).

Weathering

Immediately upon being spilled, oil begins reacting with the environment. This process is called weathering. A number of processes alter the chemical and physical characteristics of the original hydrocarbon mixture, which reduces the oil mass over time. Weathering processes include evaporation of volatile hydrocarbons into the atmosphere, dissolution of soluble components, dispersion of oil droplets into the water column, emulsification and spreading of the slick on the surface of the water, chemo- or photo-oxidation of specific compounds (creating new components that are often more soluble), and biodegradation. Weathering and the existing meteorological and oceanographic conditions determine the time that the oil remains on the surface of the water, and the characteristics of the oil at the time of contact with a particular resource also influence the persistence time of an oil slick. Oil-spill cleanup timing and effectiveness would also be determining factors.

Chemical, physical, and biological processes operate on spilled oil to change its hydrocarbon compounds, reducing many of the components until the slick can no longer continue as a cohesive mass floating on the surface of the water. By spreading out, the oil's more volatile components are exposed to the atmosphere and up to about two-thirds of the oil evaporates rapidly.

Some crude oils mix with water to form an emulsion that is much thicker and stickier than the original oil (USDOC, NOAA, 2006a). Winds and waves continue to stretch and tear the oil patches into smaller pieces, or tarballs. While some tarballs may be as large as pancakes, most are coin-sized. Tarballs are very persistent in the marine environment and can travel hundreds of miles.

The BOEM used the SINTEF model to numerically model weathering processes to (1) estimate the likely amount of oil remaining on the ocean surface as a function of time and (2) predict the composition of any remaining oil (USDOI, MMS, 2007d). The model was run for a typical oil and environmental scenarios representative of the WPA and CPA. The results of BOEM's weathering analyses were as follows. By 10 days after a spill event of ≥1,000 bbl, approximately 32-74 percent of the slick would have dissipated by natural weathering, with between 30 and 32 percent lost to the atmosphere via evaporation and between 2 and 42 percent lost into the water column via natural dispersion. The volume of the slick would be further reduced by spill-response efforts (**Chapter 3.2.1.9**).

Seafloor Release

Movement of the oil and gas industry into the deep waters of the Gulf of Mexico increasingly relies on subsea production infrastructure, possibly increasing the risk of seafloor releases. As noted earlier, the behavior of a spill depends on many factors, 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. Due in part to application of subsea dispersants, 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). After the *Ixtoc* blowout in 1979, 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 marine 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.

3.2.1.5.5. Transport of Spills ≥1,000 bbl by Winds and Currents

Using the OSRA computer model, BOEM estimates the likely trajectories of hypothetical offshore spills ≥1,000 bbl. The trajectories combined with estimated spill occurrence are used to estimate the risk of future spills occurring and contacting environmental features.

The OSRA model simulates the trajectory of a point launched from locations mapped onto a gridded area. The gridded area represents an area of the GOM and South Atlantic Bight, and the point's trajectory simulates a spill's movement on the surface of water using modeled ocean current and wind fields. The model uses temporally and spatially varying, numerically computed ocean currents and winds.

The OSRA model can simulate a large number of hypothetical trajectories from each launch point. Spill trajectories are launched once per day from each origin point and are time stepped every hour until a statistically valid number of simulations have been run to characterize the risk of contact. The simulated oil spills for this EIS were "launched" from approximately 6,000 points uniformly distributed 6-7 mi (10-11 km) apart within the Gulf OCS. This spacing between launch points is sufficient to provide a resolution that created a statistically valid characterization of the entire area (Price et al., 2001).

The model tabulates the number of times that each trajectory moves across or touches a location (contact) occupied by polygons mapped on the gridded area. These polygons represent locations of various environmental features. The OSRA model compiles the number of contacts to each environmental feature that result from all of the modeled trajectory simulations from all of the launch points for a specific area. Contact occurs for offshore features if the trajectory simulation passes through the polygon. Contact occurs for land-based features if the trajectory simulation touches the border of the feature. The simulation stops when the trajectory contacts the lines representing the land/water boundary or the borders of the domain. The probability of contact to an environmental feature is calculated by dividing the number of contacts by the number of trajectories started at various launch locations in the gridded area.

The output from this component of the OSRA model provides information on the likely trajectory of a spill by wind and current transport, should one occur and persist for the time modeled in the simulations; the calculations for this EIS were modeled for 10 and 30 days. All contacts that occurred during these periods were tabulated. A detailed description of the OSRA computer model used in this analysis is provided separately in a published report (Ji et al., in preparation).

3.2.1.5.6. Length of Coastline Affected by Offshore Spills ≥1,000 bbl

The BOEM has previously estimated the length of shoreline that could be contacted if a spill ≥1,000 bbl occurred as a result of an accident associated with a proposed action (USDOI, MMS, 2007d). The length of shoreline contacted is dependent upon the original spill size and the volume of oil removed by natural weathering and offshore cleanup operations prior to the slick making shoreline contact. The shoreline length contacted is a simple arithmetic calculation based on the area of the remaining slick. The calculation assumes that the slick will be carried 30 m (98 ft) inshore of the shoreline, either onto the beachfront up from the water's edge or into the bays and estuaries, and will be spread out at uniform thickness of 1 mm; this assumes that no oil-spill boom is used. The maximum length of shoreline affected by a spill of 4,600 bbl was estimated to be 30-50 km (19-31 mi) of shoreline, assuming such a spill were to reach land within 12 hours. Some redistribution of the oil due to longshore currents and further smearing of the slick from its original landfall could also occur.

3.2.1.5.7. Likelihood of an Offshore Spill ≥1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

A more complete measure of spill risk was calculated by multiplying the probability of contact generated by the OSRA model by the probability of occurrence of one or more spills ≥1,000 bbl as a result of a proposed action. This provides a risk factor that represents the probability of a spill occurring as a result of a proposed action and contacting the resource of concern. These numbers are often referred to as "combined probabilities" because they combine the risk of occurrence of a spill from OCS sources and the risk of such a spill contacting sensitive environmental resources. The combined probabilities are provided for each resource of concern in **Figures 3-8 through 3-28**. A discussion of spill risk to the resources is provided in **Chapter 3.2.1.8**.

To better reflect the geologic distribution of oil and gas resources and natural variances of meteorological and oceanographic conditions in the computation of combined probabilities, the BOEM also generated combined probabilities for smaller areas within the WPA and CPA. The BOEM used a cluster analysis to analyze the contact probabilities generated for each of the 6,000 launch points. For this analysis, similar trajectories and contact to 10-mi (16-km) shoreline segments were used to identify offshore cluster areas. The estimated oil production from a proposed action was proportionally distributed to the cluster areas and the likelihood of spill occurrence was calculated for each cluster area. The probability of spill occurrence was combined with probabilities of contact from the trajectory modeling to estimate the combined risk of spills occurring and contacting various resources from spills in each cluster area. To account for the risk of spills occurring from the transportation of oil to shore, generalized pipeline corridors originating within each of the offshore cluster areas and terminating at major oil pipeline landfall areas were developed. The oil volume estimated to be produced as a result of a proposed action within each cluster area was proportioned among the pipeline corridors. The mean number of spills and the probability of contact of spills from each pipeline corridor were then calculated and combined with the risk of spills occurring and contacting resources from OCS facility development and production operations to complete the analysis.

3.2.1.6. Risk Analysis for Offshore Spills <1,000 bbl

The following section addresses the risk of spills <1,000 bbl resulting from a WPA or CPA proposed action. To discuss spills <1,000 bbl, information is broken into size groups shown in **Table 3-12**.

Analysis of historical data shows that most offshore OCS oil spills have been ≤1 bbl (USDOI, BOEMRE, 2011a). Although spills of ≤1 bbl have made up 96 percent of all OCS-related spill occurrences, spills of this size have contributed very little (2%) to the total volume of OCS oil that has been spilled. Most of the total volume of OCS oil spilled (95%) has been from spills ≥10 bbl.

3.2.1.6.1. Estimated Number of Offshore Spills <1,000 bbl and Total Volume of Oil Spilled

The number of spills <1,000 bbl estimated to occur over the next 40 years as a result of a WPA or CPA proposed action is provided in **Table 3-12**. The number of spills is estimated by multiplying the oil-spill rate for each of the different spill size groups by the projected oil production as a result of a proposed action (**Table - 3-2** and **3-3**). As spill size increases, the occurrence rate decreases and so the number of spills estimated to occur decreases.

The number of spills >500 and <1,000 bbl estimated to occur is <1 for a WPA proposed action. The number of spills >500 and <1,000 bbl estimated to occur is <1-1 for a CPA proposed action.

In the spill size range of >50-500 bbl, 1-2 spills are estimated to occur from activities related to a WPA proposed action, and 5-10 spills are estimated to occur from activities related to a CPA proposed action.

Multiplying the estimated number of spills by the median or average spill sizes for each size group yields the volume of oil estimated to be spilled as a result of a proposed action over the 40-year analysis period. A total of 220-380 bbl of oil is estimated from spills <1,000 bbl as a result of a WPA proposed action. A total of 870-1,690 bbl of oil is estimated from spills <1,000 bbl as a result of a CPA proposed action.

3.2.1.6.2. Most Likely Source and Type of Offshore Spills <1,000 bbl

Most spills <1,000 bbl on the OCS would likely occur from a mishap on a production facility, most likely related to a failure related to storage of oil. From 1995 to 2009, there were 14,191 spills <1,000 bbl on platforms, rigs, or vessels and 1,139 spills from pipelines (USDOI, BOEMRE, 2011a). Spills on platforms and rigs could be crude or refined (diesel, hydraulic) oil. Reported pipeline spills are likely to be crude oil and vessel spills are likely to be refined oil. For spills <1,000 bbl, a total of 19,050 bbl were released to OCS waters from platforms, rigs, or vessels, and 8,002 bbl were released from pipelines.

3.2.1.6.3. Most Likely Size of Offshore Spills <1,000 bbl

Table 3-12 provides the most likely volume of oil estimated to be spilled for each of the spill-size groups. The median spill size is used for all spill sizes. During the 40-year analysis period, 96 percent of all spills estimated to occur as a result of a WPA or CPA proposed action would be small spills (≤1 bbl), and 2 percent of the volume of oil spilled would be the result of spills ≤1 bbl (USDOI, BOEMRE, 2011a).

3.2.1.6.4. Persistence, Spreading, and Weathering of Offshore Oil Spills <1,000 bbl

It is expected that slicks from spills <1,000 bbl will persist a few minutes (<1 bbl), a few hours (<10 bbl), or a few days (10-1,000 bbl) on the open ocean. Spilled oil would rapidly spread out, evaporate, and weather, and become dispersed into the water column. Most spills <1,000 bbl are expected to be diesel, which dissipates very rapidly. Diesel is a distillate of crude oil and does not contain the heavier components that contribute to crude oil's longer persistence in the environment.

3.2.1.6.5. Transport of Spills <1,000 bbl by Winds and Currents

To be transported by winds and currents, an oil slick must remain a drifting cohesive mass. Only spills >50 bbl have a chance of remaining a cohesive mass long enough to be transported any distance.

3.2.1.6.6. Likelihood of an Offshore Spill <1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

Because spills <1,000 bbl are not expected to persist as a slick on the surface of the water beyond a few days and because spills on the OCS would occur at least 3-10 nmi (3.5-11.5 mi; 5.6-18.5 km) from shore, it is unlikely that any spills would make landfall prior to breaking up. For an offshore spill <1,000 bbl to make landfall, the spill would have to occur proximate to State waters (defined as 3-12 mi [5-19 km] from shore). If a spill were to occur proximate to State waters, only a spill >50 bbl would be expected to have a chance of persisting long enough to reach land. Spills >50 and <1,000 bbl size are very infrequent. Should such a spill occur, the volume that would make landfall would be expected to be extremely small (a few barrels).

3.2.1.7. Risk Analysis for Coastal Spills

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. The BOEM projects that almost all (>99%) oil produced as a result of a proposed action will be brought ashore via pipelines to oil pipeline shore bases, stored at these facilities, and eventually transferred via pipeline or barge to Gulf coastal refineries. Because oil is commingled at shore bases and cannot be directly attributed to a particular lease sale, this analysis of coastal spills addresses spills that could occur prior to the oil arriving at the initial shoreline facility. It is also possible that non-OCS oil may be commingled with OCS oil at these facilities or during subsequent secondary transport.

3.2.1.7.1. Estimated Number and Most Likely Sizes of Coastal Spills

The USCG provided the database used to prepare *Polluting Incidents In and Around U.S. Waters Spill/Release Compendium, 1969-2009* (U.S. Dept. of Homeland Security, CG, 2010a). The data for the most recent 14 years, 1996-2009, were used. There were more than 18,000 spill records during this time in coastal and OCS waters across the Gulf of Mexico. The data were mapped using the latitude and longitude provided, and some points that were inland or outside of the GOM were omitted. Some broad assumptions were made in the use of these data. States vary on the distance from the coast considered to be State offshore waters or territorial seas. The Texas territorial seas extend from the shoreline to 9 nmi (3 marine leagues; 10 mi; 16 km) from the shoreline. For the purpose of comparing spill events across GOM coastal waters, spills in rivers, estuaries, and bays and 0-3 nmi (0-3.5 mi) from shore were counted as coastal spills. The number of GOM coastal spills from eight sources associated with State or Federal offshore production and international importation was determined from the data (**Table 3-21**). Louisiana and Texas have extensive oil and gas activity occurring in their territorial seas, as well as in Federal waters on the OCS. The sources that were counted are fixed platforms, MODU's, offshore marine facilities, OSV's, offshore pipelines, and unknown sources. Counts for tank ships and barges are shown but were not included as sources since <1 percent of oil production is barged and FPSO oil tankering is not yet established. The following sources were counted when present and were considered to not be related to oil and gas exploration and production in Federal waters: aircraft; deepwater port; commercial vessel; designated waterfront facility; facility particular hazard; factory; fishing boat; freight barge; freight ship; industrial facility; industrial vessel; land facility nonmarine; land vehicle; unknown; marine; MARPOL reception; unclassified tow/tug; tank truck; oil recovery; municipal facility; onshore pipeline; other onshore marine facility; passenger; unclassified public vessels; recreational; research vessel; shipyard/repair facility; and shoreline. The USCG database is comprised of four information systems, which sometimes differed in how a location or spill source was described.

In the waters 0-3 nmi (0-3.5 mi) off the Texas coast, there were a total of 250 spills reported from 1996-2009 or about 20 spills <1,000 bbl/yr. Roughly one-quarter of the spills were from oil and gas sources, half were due to activities not related to oil and gas, and the final one-quarter were due to unknown sources. Assuming that all spills designated with unknown source were actually due to State or Federal oil and gas activity, there were close to 125 spills <1,000 bbl (~10 spills <1,000 bbl/year) in the Texas coastal waters. The BOEMRE shows that 96 percent of Federal oil and gas activity spills are <1 bbl, with an average size of 0.05 bbl and that 4 percent of Federal oil and gas activity spills are 1-999 bbl, with an average size of 77 bbl (USDOI, BOEMRE, 2011a, Figure 1). Although this is a rough approximation, 20-30 bbl/yr spills from State or Federal oil and gas activity into the waters 0-3 mi (0-5 km) off of Texas annually.

In the waters 0-3 nmi (0-3.5 mi) off the Louisiana coast, there were a total of more than 3,000 spills reported from 1996 to 2009, or about 200 spills <1,000 bbl/yr. Roughly one-quarter of the spills were from oil and gas sources, one-quarter were due to activities not related to oil and gas, and half were due to unknown sources. The only spills ≥1,000 bbl to occur in coastal waters occurred in Louisiana where there were two spills from platforms in State waters (1,200 bbl and 1,000 bbl) and one spill from a waterfront facility (25,420 bbl). Assuming that all spills designated as an unknown source were actually due to State or Federal oil and gas activity, there were close to a total of 2,300 spills <1,000 bbl (160 spills <100 bbl/yr) in the Louisiana coastal waters. Using the same average spill size and size distributions described by BOEMRE, roughly 500-600 bbl/yr from State or Federal oil and gas enter coastal Louisiana waters annually (USDOI, BOEMRE, 2011a, Figure 1).

In the waters 0-3 mi (0-5 km) off the Mississippi coast, there were a total of 432 spills reported from all sources or about 30 spills <1,000 bbl/yr. Twelve spills were from sources related to State or Federal oil and gas exploration and production, and 40 spills were from unknown sources. In the waters 0-3 nmi (0-3.5 mi) off the Alabama coast, there were a total 125 spills reported from all sources from 1996 to 2009, or about 10 spills <1,000 bbl/yr. Twenty-one spills were from sources related to State or Federal oil and gas exploration and production, and seven spills were from unknown sources. Using the same average spill size and size distributions described above, roughly 10-20 bbl/yr from State or Federal oil and gas activity enter the waters 0-3 nmi (0-3.5 mi) off Mississippi and 5-10 bbl/yr enter coastal Alabama annually (USDOI, BOEMRE, 2011a, Figure 1).

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, Texas, Mississippi, and Alabama will have a total of 200, 20, 30, and 10 spills <1,000 bbl/year, respectively, from all sources. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Texas, Mississippi, and Alabama will have a total of 130-170, 5-10, 3-5, and about 2 spills <1,000 bbl/year, respectively. Louisiana and Texas are the states most likely to have a spill ≥1,000 bbl occur in coastal waters.

3.3.1.7.2. Likelihood of Coastal Spill Contact

Estimates of future coastal spills are based on historical spills reported to USCG. **Figures 3-29 and 3-30** show locations of coastal oil spills for 2008. Louisiana coastal waters are the most likely location for the occurrence of a coastal spill. A spill that occurs in Federal waters could also be transported to State waters. Again, Louisiana coastal waters would be the area most likely contacted.

3.2.1.8. Risk Analysis by Resource

The BOEM analyzed risk to resources from oil spills and oil slicks that could occur as a result of a WPA or CPA proposed action. The risk results are based on BOEM's estimates of likely spill locations, sources, sizes, frequency of occurrence, physical fates of different types of oil slicks, and probable transport that are described in more detail in the preceding spill scenarios. For offshore spills, combined probabilities were calculated using the OSRA model, which includes both the likelihood of a spill from a proposed action occurring and the likelihood of the oil slick reaching areas where known environmental resources exist. The analysis of the likelihood of direct exposure and interaction of a resource with an oil slick and the sensitivity of a resource to the oil is provided under each resource category in **Chapter 4** and in **Figures 3-8 through 3-28**. Coastal spills are estimated from historic counts; the estimate is not a rate tied to an anticipated production volume or a probability.

The environmental resources considered in the OSRA modeling were selected by BOEM analysts. This selection incorporated information from consultations with FWS and NOAA's National Marine Fisheries Service. A total of 126 onshore and 184 offshore resources were selected as input to the OSRA model. Onshore resources included the following primary categories: counties/parishes, states, birds, sea turtle habitats, manatee habitats, beach mice habitats, fish, and recreational beaches. Offshore resources included the following primary categories: State waters, islands, essential fish habitat (EFH), seagrass, *Sargassum*, habitats of particular concern (HAPC) and protected areas, seafloor, recreational diving, and marine mammal habitat. Details on the individual species covered by the above resource categories and the seasonalities associated with each are provided under each resource category in **Chapter 4**. As well, a detailed analysis of risk to each resource from oil spills and oil slicks is provided under each resource category in **Chapter 4**.

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. These estimates include volumes from spill incidents in all size groups (**Table 3-12**). A ≥10,000-bbl size group was not included in this analysis because the catastrophic DWH event was the only ≥10,000-bbl spill during the last 15 years (1996-2010); thus, meaningful statistics could not be calculated for this size group using historical spill rates (USDOI, BOEMRE, 2011a). However, output from the OSRA model provides oil-spill occurrence probability estimates for offshore spills ≥1,000 bbl and ≥10,000 bbl for both the proposed actions and OCS Program. The mean numbers of total spills ≥1,000 bbl estimated for a WPA and CPA proposed action are 0.13-0.22 and 0.52-0.98, respectively, and for the WPA and CPA OCS Program, the mean numbers of total spills are 2.84-3.88 and 17.89-23.87, respectively (Ji et al., in preparation). The mean numbers of total spills ≥10,000 bbl estimated for a WPA and CPA proposed action are 0.04-0.06 and 0.14-0.27, respectively, and for the WPA and CPA OCS Program, the mean numbers of total spills are 0.78-1.11 and 4.91-6.65, respectively.

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 levels of energy-related industry, commercial, and recreational activities remain the same. Therefore the coastal waters of Louisiana, Texas, Mississippi, and Alabama will have a total of 200, 20, 30 and 10 spills <1,000 bbl/year, respectively, from all sources. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Texas, Mississippi, and Alabama will have totals of 130-170, 5-10, 3-5, and about 2 spills <1,000 bbl/year, respectively. Louisiana and Texas are the states most likely to have a spill ≥1,000 bbl occur in coastal waters. The most likely cause is from platforms located in State waters.

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 coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a WPA or CPA proposed action (**Table 3-12**), and few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

3.2.1.9. Spill Response

3.2.1.9.1. BOEM Spill-Response Requirements and Initiatives

As a result of the Oil Pollution Act of 1990, BSEE was tasked with a number of oil-spill-response duties and planning requirements. These requirements are implemented according to BSEE's regulations at 30 CFR 250 and 254:

- requires immediate notification for spills >1 bbl—all spills require notification to USCG, and BOEM receives notification from the USCG of all spills ≤1 bbl;
- conducts investigations to determine the cause of a spill;
- assesses civil and criminal penalties, if needed;
- oversees spill source control and abatement operations by industry;
- sets requirements and reviews and approves oil-spill-response plans for offshore facilities;
- conducts unannounced drills to ensure compliance with oil-spill-response plans;
- requires operators to ensure that their spill-response operating and management teams receive appropriate spill-response training;
- conducts inspections of oil-spill-response equipment;
- requires industry to show financial responsibility to respond to possible spills; and
- provides research leadership to improve the capabilities for detecting and responding to an oil spill in the marine environment.

The BOEMRE also issued NTL's and guidance documents that clarify additional oil-spill requirements after the DWH event occurred. The spill-response-related NTL's and guidance documents issued by BOEMRE include the following NTL's:

NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources"

This NTL, effective November 8, 2010, applies only to operators conducting operations using subsea or surface BOP's on floating facilities. It explains that lessees and operators submit a statement signed by an authorized company official with each application for a well permit indicating that they will conduct all of their authorized activities in compliance with all applicable regulations, including the Increased Safety Measures Regulations at 75 FR 63346. The NTL also informs lessees that BOEM will be evaluating whether or not each operator has submitted adequate information demonstrating that it has access to and can deploy surface and subsea containment resources that would be adequate to promptly respond to a blowout or other loss of well control. The NTL notifies the operator that BOEM intends to evaluate the adequacy of each operator to comply in the operator's current OSRP; therefore, there is an incentive for voluntary compliance. The NTL lists the type of information that BOEM will review as follows:

- subsea containment and capture equipment, including containment domes and capping stacks;
- subsea utility equipment, including hydraulic power, hydrate control, and dispersant injection equipment;
- riser systems;
- remotely operated vehicles;
- capture vessels;
- support vessels; and
- storage facilities.

NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS"

This NTL, effective June 18, 2010, explains the procedures for the lessee or operator to submit supplemental information for new or previously submitted EP's, DPP's, or DOCD's. The required supplemental information includes the following: (1) a description of the blowout scenario as required by 30 CFR 550.213(g) and 550.243(h); (2) a description of their assumptions and calculations used in determining the volume of the worst-case discharge required by 30 CFR 550.219(a)(2)(iv) (for EP's) or 30 CFR 550.250(a)(2)(iv) (for DPP's and DOCD's); and (3) a description of the measures proposed that would enhance the ability to prevent a blowout, to reduce the likelihood of a blowout, and to conduct effective and early intervention in the event of a blowout, including the arrangements for drilling relief wells and any other measures proposed. The early intervention methods of the third requirement could actually include the surface and subsea containment resources that BOEMRE announced in NTL 2010-N10, which states that BOEM will begin reviewing to ensure that the measures are adequate to promptly respond to a blowout or other loss of well control.

Approval Requirements for Activities that Involve the Use of a Subsea Blowout Preventer (BOP) or a Surface BOP on a Floating Facility (BOEMRE Guidance Document)

On December 13, 2010, BOEMRE issued a press release and a guidance document to provide a clear path forward for the safe resumption of deepwater drilling operations (USDOI, BOEMRE, 2010d). This guidance clarifies, in part, that although operators are not required to amend their OSRP's to include additional subsea containment information, they may do so voluntarily. The guidance further indicates that BOEM will review OSRP's for the following specific information relating to subsea containment, in addition to that listed in NTL 2010-N10:

- source abatement through direct intervention;
- relief wells;
- debris removal; and
- if a capping stack is the single containment option offered, the operator must provide the reasons that the well design is sufficient to allow shut-in without broach to the seafloor.

An operator can comply with this guidance by submitting a Containment Plan as part of their OSRP. In evaluating the sufficiency of subsea containment information submitted by an operator, BOEM will examine the Mudline Shut-in Pressure for the proposed well. The BOEM will also evaluate factors such as debris removal from the site.

3.2.1.9.2. Offshore Response, Containment, and Cleanup Technology

In the event of a spill, particularly a loss of well control, there is no single method of containment and removal that would be 100 percent effective. Spill cleanup is a complex and evolving technology. There are many situations and environmental conditions that necessitate different approaches. New technologies constantly evolve, but they provide only incremental benefits. Each new tool then becomes part of the spill-response tool kit. Each spill-response technique/tool has its specific uses and benefits (Fingas, 1995). Removal and containment efforts to respond to an ongoing spill offshore would likely require multiple technologies, including source containment, mechanical cleanup, in-situ burning of the slick, and chemical dispersants. Even with the deployment of all of these spill-response technologies, it is likely that, with the operating limitations of today's spill-response technology, not all of the oil can be contained and removed offshore.

Because no single spill-response method is 100 percent effective, it is likely that larger spills under the right conditions will require the simultaneous use of all available cleanup methods (i.e., source containment, mechanical cleanup, dispersant application, and in-situ burning). Accordingly, the response to the DWH event employed all of these options simultaneously. The cleanup technique chosen for a spill response will vary depending upon the unique aspects of each situation. The selected mix of countermeasures will depend upon the shoreline and natural resources that may be impacted; the size, location, and type of oil spilled; weather; and other variables. The overall objective of on-water recovery is to minimize the risk of impact by preventing the spread of free-floating oil. The physical and chemical properties of crude oil can greatly affect the effectiveness of containment and recovery equipment, dispersant application, and in-situ burning. It is expected that oil found in the majority of the proposed lease sale areas could range from medium weight oil to condensate. The variety of standard cleanup protocols that were used for removing DWH oil from beaches, shorelines, and offshore water are identified in **Table 3-22.**

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 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).

The National Commission on the British Petroleum (BP) *Deepwater Horizon* Oil Spill and Offshore Drilling's staff working paper 7 (Oil Spill Commission, 2011a), entitled "Response/Clean-Up Technology Research & Development and the BP Deepwater Horizon Oil Spill," has initially indicated that, since the *Exxon Valdez* spill occurred, both the industry and government have underfunded spill-response research and development and, as a result, cleanup technology used during the DWH event was outdated and inadequate. This draft report also makes the recommendation that the Commission consider the fact that future improvements in spill prevention and source containment should not replace the need to provide incentives and funding for spill-response research and development for slick containment and removal, in part, because an exclusive focus on prevention and subsea containment is not an in-depth defense to an oil spill and it would preclude a valuable redundancy in response capability (Oil Spill Commission, 2011a). As a result of this report, the Commission is presently considering various measures that could serve to advance improvements in the present-day, spill-response technology.

Source Containment

To address the new improved containment systems' expectations to rapidly contain a spill as a result of a loss of well control from a subsea well addressed in NTL 2010-N10, several oil and gas industry majors initiated the development of a new, rapid response system. This system is designed to fully contain oil flow in the event of a potential future underwater blowout and to address a variety of scenarios. The system would consist of specially designed equipment constructed, tested, and available for rapid response. It is envisioned that this system could be fully operational within days to weeks after a spill event occurs. The system is designed to operate in up to 10,000-ft (3,048-m) water depth and adds containment capability of 100,000 bbl of oil/day (4.2 million gallons/day). This new $1 billion investment can be expanded and adapted for new technologies. This equipment should be available by Spring 2012. The companies that originated this system have formed a nonprofit organization, the Marine Well Containment Company (MWCC), to operate and maintain the system (MWCC, 2010). The MWCC will provide fully trained crews to operate the system, will ensure the equipment is operational and ready for rapid response, and will conduct research on new containment technologies. The MWCC interim capability was available on February 17, 2011. The MWCC's initial response system includes a subsea capping stack with the ability to shut in flow or to flow the oil via flexible pipes and risers to surface vessels. This interim system can operate in water depths up to 10,000 ft (2,438 m) and has storage and processing capacity for up to 60,000 bbl/day of liquids (MWCC, 2011).

Another option for source control and containment is through the use of the equipment contracted by another nonprofit organization, Helix Well Containment Group (HWCG) (Driver, 2010). The HWCG initiative involves more than 24 smaller energy companies. The HWCG has contracted the equipment that it found useful in the DWH response and offered it to oil and gas producers for use beginning January 1, 2011. This system focuses on the utilization of the *Helix Producer I* and the *Q4000* vessels. Each of these vessels played a role in the DWH response and is continually working in the Gulf. The HWCG system has the ability to fully operate in up to 10,000 ft (3,048 m) of water and has intervention equipment to cap and contain a well with the mechanical integrity to be shut-in. The HWCG system also has the ability to capture and process 55,000 bbl of oil per day (Helix Well Containment Group, 2010).

In addition, industry has a multitude of vendors available within the GOM region that can provide the services and supplies necessary for debris removal capability, dispersant injection capability, and top-hat deployment capability. Many of these vendors are already cited for use by MWCC and HWCG.

The BOEM will not allow an operator to begin drilling operations until adequate subsea containment and collection equipment, as well as subsea dispersant capability, is determined by BOEM to be available to the operator and is sufficient for use in response to a potential incident from the proposed well(s).

Mechanical Cleanup

Generally, mechanical containment and recovery is the primary oil-spill-response method used (33 CFR 153.305(a)). Mechanical recovery is the process of using booms and skimmers to pick up oil from the water surface. It is expected that the oil-spill-response equipment needed to respond to an offshore spill in the proposed WPA and CPA sale area could be called out from one or more of the following oil-spill equipment base locations: Corpus Christi, Aransas Pass, Houston, La Porte, Ingleside, Port Arthur, and Galveston, Texas; Lake Charles, New Iberia, Belle Chase, Cameron, Cocodrie, Morgan City, New Orleans, Sulphur, Houma, Fourchon, Fort Jackson, and Venice, Louisiana; Pascagoula, Mississippi; Theodore and Mobile, Alabama; or Pensacola, Fort Lauderdale, Panama City, and Tampa, Florida. Response times for any of this equipment would vary, dependent on the location of the equipment, the staging area, and the spill site; and on the transport requirements for the type of equipment procured. It is anticipated that equipment would be procured from the closest available oil-spill equipment bases.

In rough seas, a large spill of low viscosity oil, such as a light or medium crude oil, can be scattered over many square kilometers within just a few hours. Oil recovery systems typically have swath widths of only a few meters and move at slow speeds while recovering oil. Therefore, even if this equipment can become operational within a few hours, it would not be feasible for them to encounter more than a fraction of a widely spread slick (ITOPF, 2010a). For this reason, it is assumed that a maximum of 10-30 percent of an oil spill in an offshore environment can be mechanically removed from the water prior to the spill making landfall (U.S. Congress, Office of Technology Assessment, 1990). Some newer oil skimming equipment procured internationally displayed faster recovery speed during the response to the DWH event, and some changes were also made in the logistics of how skimmers and booms were positioned offshore during this response that increased the equipment's swath width. However, for the DWH event, it was estimated that only 3 percent of the total oil spilled was picked up by mechanical equipment offshore (Lubchenco et al., 2010).

A common difficulty when deploying booms and skimmers to recover oil is coordinating vessel activities to work the thickest areas of oil (ITOPF, 2010a). It is a rule of thumb that 90 percent of the oil is in 10 percent of the area. The 10 percent of the oil that makes up 90 percent of a slick is typically sheen. For this reason, containment and recovery operations on water require extensive logistical support to direct the response effort. Additionally, the limitations that poor weather and rough seas impose on spill-response operations offshore are seldom fully appreciated. Handling wet, oily, slippery equipment on vessels that are pitching and rolling is difficult and can raise safety considerations. Winds, wave action, and currents can drastically reduce the ability of a boom to contain and a skimmer to recover oil. It is important to select equipment for a response that is suitable for the type of oil and the prevailing weather and sea conditions for a region. Efforts should generally be made to target the heaviest oil concentrations and areas where collection and removal of the oil will reduce the likelihood of oil reaching sensitive resources and shorelines. As oil weathers and increases in viscosity, cleanup techniques and equipment should be reevaluated and modified (ITOPF, 2010a).

Practical limitations of strength, water drag, and weight mean that generally only relatively short lengths of boom (tens to a few hundred meters) can be deployed and maintained in a working configuration. Towing booms at sea (e.g., in U or J configurations, which increase a skimmers swath width) is a difficult task requiring specialized vessels and trained personnel (ITOPF, 2010a). Additional boom limitations are discussed in **Chapter 3.2.1.5.4**. Because skimmers float on the water surface, they experience many of the operational difficulties that apply to booms, particularly those posed by wind, waves, and currents (ITOPF, 2010a). The effectiveness of any skimmer depends upon a number of factors, in addition to the ambient weather and sea conditions, including the type of oil, the thickness of the oil, the presence of debris in the oil or in the water, and the location of the spill (Fingas, 1995). Even moderate wave motion can greatly reduce the effectiveness of most skimmer designs (ITOPF, 2010a). In high sea-state conditions, many skimmers, especially weir and suction skimmers, take up more water than oil (Fingas, 1995). Because of the various constraints placed upon skimmers in the field, their design capacities are rarely realized. Experience from numerous spills has consistently shown that skimmer recovery rates reported under test conditions cannot be sustained during a spill response (ITOPF, 2010a). The availability of sufficient oil-storage facilities is necessary to ensure continuous oil-spill recovery. This storage needs to be easy to handle and easy to empty once full so that it can be used repeatedly with the least interruption in recovery activity (ITOPF, 2010a).

There are no proven methods for the containment of submerged oil, and methods for recovery of submerged oils have limited effectiveness. Efforts to mechanically contain and/or recover suspended oil have focused on different types of nets, either the ad hoc use of fishing nets or specially designed trawl nets. There has been some research conducted on the design of trawl nets for the recovery of emulsified fuels. However, the overall effectiveness for large spills is expected to be very low. The suspended oil can occur as liquid droplets or semisolid masses in sizes ranging from millimeters to meters in diameter (Coastal Response Research Center, 2007). At spills where oil has been suspended in the water column, responders have devised low technology methods for tracking the presence and spread of oil over space and time. For suspended oil, these methods include stationary systems such a snare sentinels, which can consist of any combination of the following: a single length of snare on a rope attached to a float and an anchor; one or more crab traps on the bottom that are stuffed with snare; and minnow or other type of traps that are stuffed with snare and deployed at various water depths. The configuration would depend upon the water depth where the oil is located within the water column. At present, it is not possible to determine the particle size, number of particles, or percent oil cover in the water column based upon the visual observations of oil on these systems (Coastal Response Research Center, 2007).

Spills involving submerged oil trigger the need for real-time data on current profiles (surface to bottom), wave energy, suspended sediment concentrations, detailed bathymetry, seafloor sediment characteristics, and sediment transport patterns and rates. These data are needed to validate or calibrate models (both computer and conceptual), direct sampling efforts, and predict the behavior and fate of the submerged oil. This information might be obtained through the use of acoustic Doppler current profilers, dye tracer studies, rapid seafloor mapping systems, and underwater camera or video systems that could record episodic events (Coastal Response Research Center, 2007). During the DWH event, fluorometers were used successfully to detect the presence of oil.

If an oil spill occurs during a storm, spill response from shore would occur following the storm. Spill response would not be possible while storm conditions continued, given the sea-state limitations for skimming vessels and containment boom deployment. However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high end aromatic compounds present).

Dispersants

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced, allowing wind and wave action to break the oil into tiny droplets that are dispersed into the upper portion of the water column. Oil that is chemically dispersed at the surface will move into the top 20 ft (6 m) of the water column where it will mix with surrounding waters and begin to biodegrade (U.S. Congress, Office of Technology Assessment, 1990, p. 19). Dispersant use, in combination with natural processes, breaks up the oil into smaller components that allows them to dissipate into the water and degrade more rapidly (Nalco, 2010). Dispersion increases the likelihood that the oil will be biodegraded, both in the water column and at the surface. While there is more analysis to be done to quantify the rate of biodegradation in the GOM after the DWH event, early observations and preliminary research results seemed to indicate that the oil biodegraded quickly; however, there are still ongoing studies assessing this issue. Bacteria that break down the dispersed and weathered surface oil are abundant in the GOM in large part because of the warm water, the favorable nutrient and oxygen levels, and the fact that oil enters the GOM through natural seeps regularly (Lubchenco et al., 2010).

Dispersant use must be in accordance with the Regional Response Team's (RRT) Preapproved Dispersant Use Manual and with any conditions outlined within a RRT's site-specific, dispersant approval given after a spill event. Consequently, dispersant use would be in accordance with the restrictions for specific water depths, distances from shore, or monitoring requirements. At this time, this manual does not give preapproval for the application of dispersant use subsea. However, USEPA is presently revisiting these RRT preapprovals in light of the dispersant issues, such as subsea application, that arose during the DWH response. The USEPA issued a letter dated December 2, 2010, that provided interim guidance on the use of dispersants for major spills that are continuous and uncontrollable for periods greater than 7 days and for expedited approval of subsurface applications. This letter outlined the following exceptions to the current preapprovals until they are updated:

- dispersants may not be applied to major spills that are continuous in nature and uncontrollable for a period greater than 7 days;
- additional dispersant monitoring protocols and sampling plans may be developed that meet the unique needs of the incident; and
- subsurface dispersants may be approved on an incident-specific basis as requested by the USCG On-Scene Commander.

More robust documentation may be required. This documentation would include daily reports that contain the products used, the specific time and locations of application, equipment used for each application, spotter aircraft reports, photographs, vessel data, and analytical data.

For a deepwater (>1,000 ft; >305 m water depth) spill ≥1,000 bbl, dispersant application may be a preferred response in the open-water environment to prevent oil from reaching a coastal area, in addition to mechanical response. However, the window of opportunity for successful dispersant application may be somewhat narrower for some deepwater locations that are dependent upon the physical and chemical properties of oil, which tend to be somewhat heavier than those found closer to shore. A significant reduction in the window of opportunity for dispersant application may render this response option ineffective.

Based on the present location of dispersant stockpiles and dispersant application equipment in the GOM, it is expected that the dispersant application aircraft initially called out for an oil-spill response to an offshore spill in the proposed WPA and CPA lease sale areas will come from Houma, Louisiana; Stennis, Mississippi; or Mesa, Arizona. The dispersants will come from locations primarily in Texas and Louisiana. Response times for this equipment would vary, depending on the spill site and on the transport time for additional supplies of dispersants to arrive at a staging location. Based on historic information, this EIS assumes that dispersant application will be effective on 20-50 percent (S.L. Ross Environmental Research Ltd., 2000) of the treated oil.

If an oil spill occurs during a storm, the dispersant application would occur following the storm. Aerial and vessel dispersant application would not be possible while storm conditions continued. However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high-end aromatic compounds present).

In-situ Burning

In-situ burning is an oil-spill cleanup technique that involves the controlled burning of the oil at or near a spill site. The use of this spill-response technique can provide the potential for the removal of large amounts of oil over an extensive area in less time than other techniques. In-situ burning involves the same oil collection process used in mechanical recovery, except instead of going into a skimmer, the oil is funneled into a fire boom, which is a specialized boom that has been constructed to withstand the high temperatures from burning oil. While in-situ burning is another method for disposing of oil that has been collected in a boom, this method is typically more effective than skimmers when the oil is highly concentrated. In-situ burning was successfully used in 411 burns during the DWH spill response, successfully eliminating between 220,000 and 300,000 bbl of oil from the water surface (Allen, 2010), approximately 5 percent of the Macondo oil spilled (Lubchenco et al., 2010).

Because of the successful use of this technology during the DWH spill response, the Gulf of Mexico's Oil Spill Removal Organizations have procured fire boom, which they have strategically stockpiled throughout the GOM region. Response times for bringing a fire-resistant boom onsite would vary, depending on the location of the equipment, the staging area, and the spill site. If an oil spill occurs during a storm, in-situ burning would occur following the storm. In-situ burning would not be possible while storm conditions continued.

Natural Dispersion

Depending upon environmental conditions and spill size, the best response to a spill may be to allow the natural dispersion of a slick to occur. Natural dispersion may be a preferred option for smaller spills of lighter nonpersistent oils and condensates that form slicks that are too thin to be removed by conventional methods and that are expected to dissipate rapidly, particularly if there are no identified potential impacts to offshore resources and a potential for shoreline impact is not indicated. In addition, natural dispersion may also be a preferred option in some nearshore environments, such as a marsh habitat, when the potential damage caused by a cleanup effort could cause more damage than the spill itself.

3.2.1.9.3. Oil-Spill-Response Assumptions Used in the Analysis of a Most Likely Spill ≥1,000 bbl Incident Related to a Proposed Action

Table 3-23 and **Chapter 3.2.1.9.3** presents the estimated amounts of oil that will either be removed by the application of dispersants or mechanically recovered for the 4,600-bbl pipeline spill scenarios analyzed in this EIS. The scenarios assumed oils within a range of 30^{o} and 35^{o} API, which are typical for the Gulf of Mexico.

3.2.1.9.4. Onshore Response and Cleanup

Offshore response and cleanup is preferable to shoreline cleanup; however, if an oil slick reaches the coastline, it is expected that the specific shoreline cleanup countermeasures identified and prioritized in the appropriate Area Contingency Plans (ACP's) for various habitat types would be used. The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. Shorelines of low productivity and biomass can withstand more intrusive cleanup methods such as pressure washing. Shorelines of high productivity and biomass are very sensitive to intrusive cleanup methods and, in many cases, the cleanup is more damaging than allowing natural recovery.

Oil-spill-response planning in the U.S. is accomplished through a mandated set of interrelated plans. The ACP's cover subregional geographic areas and represent the third tier of the National Response Planning System mandated by OPA. The ACP's are a focal point of response planning, providing detailed information on response procedures, priorities, and appropriate countermeasures. The Gulf coastal area that falls within USCG District 8 is covered by the One Gulf Plan ACP, which includes separate Geographic Response Plans for areas covered by USCG Sector Corpus Christi, Sector Houston/ Galveston, Sector Port Arthur, Sector Morgan City, Sector New Orleans, and Sector Mobile. The Miami ACP covers the remaining Gulf coastal area. The ACP's are written and maintained by Area Committees assembled from Federal, State, and local governmental agencies that have pollution response authority; nongovernmental participants may attend meetings and provide input. The coastal Area Committees are chaired by respective Federal On-Scene Coordinators from the appropriate USCG Office and are comprised of members from local or area-specific jurisdictions. Response procedures identified within an ACP or its Geographic Response Plan(s) reflect the priorities and procedures agreed to by members of the Area Committees.

If an oil slick reaches the coastline, the responsible party will be required to use the specific shoreline cleanup countermeasures identified and prioritized for the various habitat types potentially impacted in the appropriate ACP's that cover these areas. However, due to the lack of specific and detailed response information in the existing Gulf of Mexico ACP's, the response to the DWH event required that separate, more detailed plans be developed for protection of these shoreline areas after much additional consultation between the Unified Command and local government agencies.

The single, most-frequently recommended, spill-response strategy for the areas identified for protection in all of the applicable ACP's or its Geographic Response Plans is the use of a shoreline boom to deflect oil away from coastal resources such as seagrass beds, marinas, resting areas for migratory birds, bird and turtle nesting areas, etc. Since oil spilled at sea tends to move and spread rapidly into very thin layers, boom is deployed to corral the oil on the water to enhance recovery effectiveness of skimmers and other response technologies. Boom is also used to protect shoreline areas and to minimize the consequences of an oil spill reaching shore. There are tradeoffs in deciding where and when to place boom because, once deployed, boom is time consuming to tend and to relocate. For example, booming operations are sensitive to wind, wave, and currents and need to be tethered and secured to keep them from moving. Rough seas can tear, capsize, or shred boom. Currents over 1.5 kn (1.7 mph) or even a wake from a boat can send oil over or under a boom. Untended boom can become a barricade to wildlife and to ship traffic. Boom anchors can damage some habitats. During the DWH event, it was discovered that hard boom often did more damage in the marsh it was intended to protect than anticipated after weather conditions ended up stranding the boom back into the marsh (USDOC, NOAA, 2010a).

If a shoreline is oiled, the selection of the type of shoreline remediation to be used will depend on the following: (1) the type and amount of oil on the shore; (2) the nature of the affected coastline; (3) the depth of oil penetration into the sediments; (4) the accessibility and the ability of vehicles to travel along the shoreline; (5) the possible ecological damage of the treatment to the shoreline environment; (6) weather conditions; (7) the current state of the oil; and (8) jurisdictional considerations. To determine which cleanup method is most appropriate during a spill response, decisionmakers must asses the severity and nature of the injury using Shoreline Cleanup and Assessment Team survey observations. These onsite decisionmakers must also estimate the time it will take for an area to recover in the absence of cleanup (typically considering short term to be 1-3 years, medium term to be 3-5 years, and long term greater than 5 years (National Response Team, 2010). The variety of standard cleanup protocols that were used for removing DWH oil from beaches, shorelines, and offshore water are identified in **Table 3-22.**

Shoreline Cleanup Countermeasures

The following assumptions regarding the clean up of spills that contact coastal resources in the area of consideration reflect a generalization of the site-specific guidance provided in the ACP's or its Geographic Response Plans applicable to the GOM. As stated in **Chapter 3.1.1.7**, it is expected that a typical oil spilled as a result of an accident associated with a WPA or CPA proposed action would be within the range of 30-35° API. Since the following discussion is intended to address the most likely spill scenario discussed in **Chapter 3.2.1.5.3**, cleanup countermeasures for medium-weight oil are all that are included in the following discussion. The ACP's applicable to the Gulf coastal area cover a vast geographical area. The differences in the response priorities and procedures among the various ACP's or its Geographic Response Plans reflect the differences in the identified resources needing spill protection in the area covered by each ACP or the Geographic Response Plans.

- *Barrier Island/Fine Sand Beaches Cleanup*: After the oiling of a barrier island/fine sand beach with a medium-weight oil, applicable cleanup options are manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, shore removal/replacement, and warm-water washing. Other possible shoreline countermeasures include low-pressure cold-water washing, burning, and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; passive collection (sorbents); high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting.
- *Fresh or Salt Marsh Cleanup*: In all cases, cleanup options that avoid causing additional damage to the marshes will be selected. After the oiling of a fresh or salt marsh with medium-weight oil, a preferred cleanup option would be to take no action. Another applicable alternative would be trenching (recovery wells). Shore removal/replacement, vegetation cutting, or nutrient enhancement could be used. The option of using vegetation cutting as a shoreline countermeasure will depend upon the time of the year and will be considered generally only if the re-oiling of birds is possible. Chemical treatment, burning, and bacterial addition are countermeasures under consideration. Responders are advised to avoid manual removal, passive collection, debris removal/heavy equipment, sediment removal, cold-water flooding, high- or low-pressure cold-water washing, warm-water washing, hot-water washing, slurry sand blasting, and shore removal/replacement.
- *Coarse Sand/Gravel Beaches Cleanup*: After the oiling of coarse sand/gravel beach with medium-weight oil, applicable cleanup options are manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, and shore removal/replacement. Other possible shoreline countermeasures include low-pressure, cold-water washing; burning; warm-water washing; and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; passive collection (sorbents); high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting.
- *Exposed or Sheltered Tidal Flats Cleanup*: After the oiling of an exposed or sheltered tidal flat with medium-weight oil, the preferred cleanup option is no action. Other applicable shoreline countermeasures for this resource include trenching (recovery wells) and cold-water deluge flooding. Other possible shoreline countermeasures listed include low-pressure, cold-water washing; vacuum; vegetation cutting; and nutrient enhancement. Responders are requested to avoid manual removal; passive collection; debris removal/heavy equipment; sediment removal; high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; and shore removal/replacement.
- *Seawall/Pier Cleanup*: After the oiling of a seawall or pier with a medium-weight oil, the applicable cleanup options include manual removal; cold-water flooding; low- and high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; vacuum; and shore removal replacement. Other possible shoreline countermeasures listed include burning and nutrient enhancement. Responders are requested to avoid no action, passive collection (sorbents), trenching, sediment removal, and vegetation cutting.

3.2.2. Losses of Well Control

The BOEM requires that all losses of well control be reported to BOEM. Effective July 17, 2006, this Agency revised the regulations for loss of well control incident reporting, which were further clarified in NTL 2010-N05, “Increased Safety Measures for Energy Development on the OCS,” effective June 8, 2010. Operators are required to document any loss of well control event, even if temporary, and the cause of the event by mail or email to the addressee indicated in the NTL. The operator does not have to include kicks that were controlled but should include the release of fluids through a flow diverter (a conduit used to direct fluid flowing from a well away from the drilling rig).

The current definition for loss of well control is as follows:

- uncontrolled flow of formation or other fluids (the flow may be to an exposed formation [an underground blowout] or at the surface [a surface blowout]);
- uncontrolled flow through a diverter; and/or
- uncontrolled flow resulting from a failure of surface equipment or procedures.

Not all loss of well control events result in blowouts; defined as any of the 3 loss of well control events above, but most commonly thought of as a release to the human environment. A loss of well control can occur during any phase of development, i.e., exploratory drilling, development drilling, well completion, production, or workover operations. A loss of well control can occur when improperly balanced well pressure results in sudden, uncontrolled releases of fluids from a wellhead or wellbore (PCCI Marine and Environmental Engineering, 1999; Neal Adams Firefighters, Inc., 1991). From 2006 to 2009, of the 23 loss of well control events reported in the GOM, 6 (26%) resulted in loss of fluids at the surface or underground (USDOI, BOEMRE, 2010e). In addition to spills, the loss of well control can resuspend and disperse bottom sediments. Historically, since 1971, most OCS blowouts have resulted in the release of gas; blowouts resulting in the release of oil have been rare.

The most recent blowout occurred on April 20, 2010, at the Macondo well in Mississippi Canyon Block 252. Although this is statistically a rare event, the blowout resulted in the release of 4.9 million bbl of oil (Lubchenco et al., 2010) and large quantities of gas to the subsea environment. To date, a gas volume release for Macondo has not been officially calculated as a Government estimate, but BOEM has made an estimate of 15 Bcf of gas released by Macondo, in absence of any other attempt at quantifying the release (DeCort, official communication, 2010). A multiagency Government estimate for the oil released by Macondo was made by Lubchenco et al. (2010) in early August 2010 and has not been revised to date.

Prior to the DWH event, two of the largest spills resulting from blowouts on the Gulf of Mexico OCS occurred in 1970, releasing 30,000 and 40,000 bbl of oil, respectively. Since 1970 there has been a total of 13 losses of well control events that have resulted in >50 bbl of oil being spilled. Most of these losses of well control were of short duration, more than one-half lasting less than a day (USDOI, BOEMRE, 2010e). In contrast, the DWH event continued uncontained for 87 days, between April 20 and July 15, 2010.

As shown by the DWH event, the loss of well control in deep water has presented obstacles and challenges that would not be encountered during a loss of well control in shallow waters. Although many of the same techniques used for wild well control efforts in shallow water were used to attempt to control the Macondo well, these well control efforts were hindered by water depth, which required reliance solely upon the use of ROV's for all well intervention efforts. This is a concern in deep water because the inability to quickly regain control of a well increases the size of a spill, as occurred during the DWH event. The DWH event required that the operator attempt well-control efforts at the seabed in very deep water depths (over 5,000 ft; 1,524 m), and after the explosions and fire that sunk the *Deepwater Horizon*, key personnel were missing who could have accessed surface switches to shut down the well if a functional BOP was installed.

As indicated by Neal Adams Firefighters, Inc. (1991) and by the DWH event, there are several options that could be attempted to control a well blowout. Common kill techniques include (1) bridging, (2) capping/shut-in, (3) capping/diverting, (4) surface stinger, (5) vertical intervention, (6) offset kill, and (7) relief wells (Neal Adams Firefighters, Inc. 1991). Although much has been learned about well control in deep water as a result of the DWH event, if a deepwater subsea blowout occurs in the future, it is likely that an operator would be required to immediately begin to drill one or more relief wells to gain control of the well. This may be required whether or not this is the first choice for well control because the relief well is typically considered the ultimate final solution for regaining well control in such circumstances.

Although it can take months, the actual amount of time required to drill the relief well depends upon the following: (1) depth of formation below mudline; (2) complexity of the intervention; (3) location of a suitable rig; (4) type of operation that must be terminated in order to release the rig (e.g., may need to complete a casing program before releasing the rig); and (5) any problems mobilizing personnel and equipment to the location.

The major differences between a blowout during the drilling phase versus the completion or workover phases is the drilling well tendency to “bridge off.” Bridging is a phenomenon that occurs when severe pressure differentials are imposed at the well/reservoir interface and the formation around the wellbore collapses and seals the well. Deepwater reservoirs are susceptible to collapse under “high draw down” conditions. However, a completed well may not have the same tendency to passively bridge off as would a drilling well involving an uncased hole. Bridging would have a beneficial effect for spill control by slowing or stopping the flow of oil from the well (PCCI Marine and Environmental Engineering, 1999). There is a difference of opinion among blowout specialists regarding the likelihood of deepwater wells bridging naturally in a short period of time. Completed wells, or those in production, present more severe consequences in the event of a blowout due to the hole being fully cased down to the producing formation, which lowers the probability of bridging (PCCI Marine and Environmental Engineering, 1999). Therefore, the potential for a well to bridge is greatly influenced by the phase of a well. See **Chapter 3.2.1.5** for a discussion of planned well-source containment options that were designed to address an ongoing loss of well control event.

In 2007, this Agency (Izon et al., 2007) looked at the occurrences of blowouts during a 15-year period. From 1992 to 2006, 39 blowouts occurred at a rate of one blowout for every 387 wells drilled. These numbers are down from the previous 15-year period where 87 blowouts occurred at a rate of one blowout for every 246 wells drilled. The majority of blowouts (84%) occurred at water depths <500 ft (152 m), which corresponds to where most of the wells in the GOM have been drilled. Forty-one percent of the blowouts lasted 1-7 days, and cementing problems were associated with 18 of the 39 blowouts. Flow diverters, which channel drilling fluid under normal circumstances but during a blowout would channel oil or gas, were used in 20 of the 39 blowouts with success reported in 16 out of 20. The occurrence of loss of well control events has improved over the last 25 years, and most loss of well control events are recoverable onsite and result in no environmental releases. Industry challenges remain as operators move into ultra-deepwater areas and seek deeper geologic prospects with little knowledge of the subsurface environment and with the use of new technologies in both familiar and unfamiliar environments.

Blowout Preventers

A BOP is a device with a complex of choke lines and hydraulic rams mounted atop a wellhead designed to close the wellbore with a sharp horizontal motion that may cut through or pinch shut casing and sever tool strings. Depending on how it is configured, a BOP could weigh 250 tons and cost from $25 to $35 million, and higher. The BOP’s were invented in the early 1920’s and have been instrumental in ending dangerous, costly, and environmentally damaging oil gushers on land and in water. The BOP’s have been required for OCS oil and gas operations from the time offshore drilling began in the late 1940’s.

The BOP’s are actuated as a last resort upon imminent threat to the integrity of the well or the surface rig. For cased wells, the normal situation, the hydraulic ram may be closed if oil or gas from an underground zone enters the wellbore to destabilize it. By closing a BOP, usually by redundant surface-operated and hydraulic actuators, the drilling crew can prevent explosive pressure release and allow control of the well to be regained by balancing the pressure exerted by a column of drilling mud with formation fluids or gases from below.

Surface BOP’s typically differ from subsea BOP’s by the reduced redundancy in the stack. This is in part due to the ease of maintenance and repair to the stack at the surface in comparison to the subsea BOP, which may have to be retrieved for these issues. As there are typically less components, the surface BOP stacks are lighter as a result. The differences in typical configuration between surface BOP’s and subsea BOP’s are shown below, from the top to the bottom of typical BOP stacks.

Subsea BOP	Surface BOP
Upper Annular Preventer	Annular Preventer
Lower annular Preventer	NE
Blind Shear Ram	NE
Upper Pipe Ram	Upper Pipe Ram
Choke Valves	Middle Pipe Ram
Middle Pipe Ram	Choke Valves
Lower Pipe Ram	Lower Pipe Ram
Subsea Isolation Device	NE

NE = no equivalent
Source: MCS Advanced Subsea Engineering (2010, Table 3.2).

Both annular and shear rams are typically configured together in the subsea BOP stack to create redundancy. Because BOP's are important for the safety of the drilling crew, as well as the rig and the wellbore itself, BOP's are regularly inspected, tested, and refurbished. The post-DWH event regulations and inspection program required for BOP's is discussed below and in **Chapter 1.3.1**. Among the changes are new provisions for BOP testing.

The most important components of the BOP for regaining control of a wild well are rams. There are four types of rams: pipe ram; annular preventer; shear ram; and blind shear ram (MCS Advanced Subsea Engineering, 2010, pp. 17-20).

Pipe Ram

A pipe ram is an element that acts as a seal in the BOP. There are rams for high-pressure and low-pressure applications. Pipe rams were historically comprised of two half circles that were designed to seal around the drill pipe; however, there are newer styles of rams that are variable and that fit a range of pipe sizes.

Annular Preventer

The annular preventer is a component of the pressure control system in the BOP that is usually situated at the top of the stack. It is a device that can form a seal in the annular space around any object in the wellbore or upon itself, enabling well control operations to commence. A reinforced elastomer packing element is compressed by hydraulic pressure to affect the seal.

Blind Ram and Blind Shear Ram

A blind ram is used to seal an open hole when there are no tools or drill string in the bore. Blind shear rams have a cutting edge that is designed to shear drill string, casing, or production tubing that may be in the hole, allowing the blind rams to seal the hole. Blind rams are intended to seal against each other to effectively close the hole; they are not intended to seal against any drill pipe or casing.

Subsea Isolation Device

A subsea isolation device allows a well to be sealed below the BOP stack to allow the rig or drillship to move off location in case of an emergency disconnect situation, such as an approaching hurricane. Where there is the need to disconnect from the wellhead in a blowout or other well control situation, a subsea isolation device may be used. The subsea isolation device is placed at the mudline with riser and wellhead connectors set up to allow emergency disconnect if needed. The subsea isolation devices have different names depending on the operator and manufacturer. They can be called a subsea isolation device, environmental safety guard, surface disconnect system, or subsea shut-off device, just to name a few. The subsea isolation device is not designed for typical well control and is not considered a BOP. It is designed to seal the well and disconnect the riser from the seafloor if required, allowing safe well abandonment and the possibility to enter the well at a later point. The subsea isolation devices are typically activated with an acoustic trigger or from an ROV control panel.

Choke Valves

Choke valves are the means of controlling the BOP or subsea isolation device functions. They can either be fixed or adjustable. An adjustable valve has the advantage of allowing more control over fluid control parameters; however, under prolonged use, they may be more susceptible to erosion than fixed valves.

This Agency's role during the efforts to actuate the BOP after the sinking of the DWH drilling ship was evaluated in Staff Working Paper 6 for the National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling (Oil Spill Commission, 2011b, pp. 4-7). The staff's evaluation described limited supervision by this Agency in the early spill containment effort, but it was in line with this Agency's established role in overseeing deepwater drilling in general. The Commission staff attributed this Agency's role to stem from a lack of resources and absence of important operational expertise (Oil Spill Commission, 2011b, pp. 7-8).

Blowout Preventer Effectiveness

The Technology Assessment & Research (TA&R) Program is a research element within BOEM's Regulatory Program. The TA&R Program supports research associated with operational safety and pollution prevention, as well as oil-spill response and cleanup capabilities. The TA&R Program was established in the 1970's to ensure that industry operations on the OCS incorporated the use of the best available and safest technologies, subsequently required through the 1978 OCSLA amendments and Energy Policy Act of 2005 (EPAct). The TA&R Program is comprised of three functional research activities: operational safety and engineering research; oil-spill-response research; and renewable energy research. There is no automatic connection between TA&R research outputs and changes to BOEM requirements. Management discretion is involved between the research outputs produced by TA&R and how or if they lead to a change in regulation.

The studies carried out by this Agency on the effectiveness of BOP's over the last 12 years have resulted in a mixed assessment of their effectiveness. An unavoidable condition involved in any BOP study to sample unit effectiveness is that a test is destructive for the casing or drill string components elected as representative and is also unique to the conditions under which the test was deployed. Tests should be as realistic as possible of in-situ conditions and materials used. As a review of the TA&R studies that have been undertaken shows (below), this is not often the case. This Agency has never required destructive testing; such a program has not been proposed in recent BOEM, post-DWH regulations (**Chapter 1.3.1**). Routine destructive testing of equipment like a BOP may diminish its lifespan making such a test program costly.

Another train of assumption that underpins effectiveness testing would be (1) that other BOP units from a manufacturer are assumed to be representative of the same type and design, (2) that units are maintained according to specification, and (3) that all modifications or maintenance for BOP units available for deployment have been carried out under a system of design control and configuration management so that rig crews know that a properly maintained or modified unit is deployed, and so that if a crew has occasion to actuate a BOP in an emergency, they have access to accurate drawings for any modification that may have been made to it. For example, there were apparently modifications made to the Macondo BOP in a maintenance overhaul. The spill-response engineers seeking to activate the BOP with ROV's did not understand what modifications had been made and did not have accurate drawings of its modified configuration (Webb, 2010).

Tetrahedron, Inc. (1996) conducted a study using data provided by the oil industry to determine BOP failure rates when tested at 7- and 14-day time intervals. The regulation 30 CFR 250.57 at that time required that a BOP must be tested when

- installed;
- before drilling each string of casing or before continuous operations in cases where the cement is not drilled out; and
- at least once a week, but not exceeding 7 days between pressure tests, alternating between control stations. A period of more than 7 days between BOP tests is allowed

> when there is a stuck pipe or there are pressure control operations and remedial efforts are being performed, provided that the pressure tests are conducted as soon as possible and before normal operation resumes.

When a unit is deployed on a well site and installed, BOEM requires a pressure-up and hold time test for the ram components without actually actuating the rams in the field. Tests succeed or fail on the ability for the system to hold specified pressures at intervals from 3 to 5 minutes. Tetrahedron, Inc. (1996) used the data to look at BOP component failures as well as failure rates between surface BOP's and subsea BOP's. For this study, a test of BOP failure was reported when any piece of equipment had to be physically repaired or sent to the shop for repairs for both initial and subsequent tests. Data were collected from 155 BOP (surface and subsea) tests, from which 63 were reported as failures (41%). When looking at surface versus subsea BOP's, 22 out of 50 surface tests failed (44%) and 12 out of 56 subsea tests failed (21%).

As a result of this study, this Agency proposed a rule change to lengthen the pressure testing interval to not exceed 14 days (*Federal Register*, 1997b) and expanded on how testing was to be carried out for BOP's in general. This Agency concluded that no statistical difference existed in failure rates for BOP's tested between 0- to 7-day intervals and 8- to 14-day intervals (*Federal Register*, 1998, p. 29604). That is to say, the testing interval was not a controlling factor. This Agency, in effect, accepted that whether tested every 7 days or every 14 days, equivalent marginal test results were obtained. The rule was finalized (*Federal Register*, 1998), amending 30 CFR 250.406, 250.407, and 250.516 in line with the proposed changes to expand required BOP testing to the longer interval.

Holand (1999) conducted a study on the reliability of subsea BOP's for deepwater applications reported for 83 wells drilled in the years 1997 and 1998. He looked at the number of days the BOP's were in service and the number of hours lost due to reported BOP failures. The failures were also classified as safety noncritical and safety critical. Safety noncritical failures are failures that occur on the rig during operation and testing of the BOP, whereas safety critical failures occur after testing and during a period in which the BOP is acting as a barrier. There were 117 BOP safety critical failures reported during 4,009 BOP service days, with a total of 3,637.5 hours lost. The failure rate for safety critical systems, the point at which the BOP was preventing a gas or fluid release, was 57 percent. The main cause of BOP failures were the ram preventers and the main control systems.

Holand and Skalle (2001) conducted a study looking at BOP performance and deepwater kicks. This study ties back to the Holand (1999) study that reported 117 BOP failures for 83 wells drilled in the years 1997 and 1998. There were 48 pressure kicks reported during the drilling of the 83 wells. There are various techniques used to suppress and equalize pressure kicks (kick-killing operations), and Holand and Skalle concluded that kick killing operations were a likely contributor to four of the BOP failures.

West Engineering Services (2002) conducted a study on the shearing capability of the BOP shear ram based on results of fully actuated BOP's from operator-provided effectiveness tests. Data were provided from seven rigs that conducted tests without hydrostatic pressure and from six rigs that tested with hydrostatic pressure. This study looked at both operational and nonoperational conditions. Five of seven tests passed (71%) the test without the hydrostatic pressure, but only three of six passed (50%) the test that accounted for increased hydrostatic pressure. The study acknowledged that different grades of casing were not tested.

When shear tests are conducted, operational parameters, such as the increased hydrostatic pressure at deepwater depths or the complete range of casing steel or pipe thicknesses, are rarely factored in. If a BOP is actuated at a casing joint, the casing is greatly overthickened at that point. Barstow et al. (2010) reported that pipe joints can make up almost 10 percent of the drill pipe's length. Should the shear ram be opposite the threading or upset (the thickening of the pipe to compensate for the threads that may be externally or internally expressed on the pipe wall) of a pipe joint, the ram would be trying to shear a pipe overthickened perhaps beyond its design specifications. However, if two rams are part of the BOP configuration, at least one ram is likely to be opposite pipe without a joint at all times. The BOP's account for such a condition by using both pipe and annular rams at different levels in the BOP stack; the assumption being that redundant system would be failsafe. Double ram configurations, however, were not required by this Agency or by current post-DWH event BOEM regulations. (**Chapter 1.3.1**).

West Engineering Services (2004) conducted a study to evaluate if a rig's BOP equipment could shear pipe to be used in a given drilling program at the most demanding condition to be expected. The study was prompted by the advances in drilling pipe metallurgy combined with larger and heavier pipe sizes used in deepwater drilling programs. West Engineering Services (2004, p. 3-1) evaluation followed their 2002 study that referred to the 2002 results as "a grim snapshot" of industry's preparedness. West reported that the latest generation of high-ductility drilling pipe has been seen in some cases to double the shearing pressures required to sever the pipe compared with lower ductility pipe of the same weight, diameter, and grade through which only careful record keeping aboard the rig can determine which pipe is of what specification. West Engineering Services (2004) concluded that pressures that should be considered when predicting successful pipe shear often are not, such as net hydrostatic pressure at water depth (combined pressure effects of seawater, BOP hydraulic fluid, and drilling mud) and closing rams against the pressure in a wellbore kick. The following are among West Engineering Services' recommendations: (1) design BOP stack for drilling programs using the worst-case information, such as maximum anticipated drilling pipe specifications, and compensatory pressures at depth acting to require a higher shear strength to separate pipe; (2) establish a maximum length for tool joints and upsets; (3) stop designating drill pipe weight per foot in favor of actual pipe wall thickness; (4) establish an industry-wide database of shear forces/pressures in materials tests carried out by prescribed procedure with prescribed test parameters and material test specifications; and (5) encouraging industry to share data, a role for this Agency. Part of the post-DWH event, spill regulatory changes for 30 CFR 250.416(e) is that third-party verification is required for all BOP's that the blind-shear rams installed in the BOP stack are capable of shearing the drill pipe in the hole under maximum anticipated surface pressure.

West Engineering Services (2006) conducted a study to assess the acceptability and safety of using equipment, particularly BOP's and wellhead components, at pressures in excess of rated working pressure. Running equipment in excess of the maximum operating pressure is considered a poor practice and is rarely seen except for accidental or emergency use. If equipment is damaged during operation over maximum working pressure, the study implied that a downgrade would be a temporary remedy until the system is removed from service or until repaired.

Melendez et al. (2006) wrote his Master's Thesis at Texas A&M on the risk assessment of surface versus subsea BOP's on MODU's. Melendez et al. determined that the reliability of the surface BOP system compared with the subsea BOP system was nearly equal. This was the case even as the subsea BOP system used more redundant components than the surface BOP system. Melendez et al. (2006) also determined that the addition of a subsea isolation device improved the system reliability and recommended subsea isolation devices be used for deepwater operations in the GOM.

MCS Advanced Subsea Engineering (2010) conducted a risk analysis on the use of surface BOP's. MCS Advanced Subsea Engineering concluded that a surface BOP carries more potential risk to the vessel and personnel, but it may not increase the overall risk of the operation. Although the BOP is closer to the vessel and allows easy access by rig personnel, the crew exposure time during a wild well condition is lessened because of a simpler and cleaner kill operation at the surface. Proper inspections and maintenance is critical because the BOP is the only barrier between the vessel and personnel during a catastrophic blowout condition.

Conclusions

Izon et al. (2007) indicate that approximately 10 percent of all wells drilled experienced some loss of well control incidents over the years 1992-2006, an improvement from 35 percent in the previous 15-year period. Most loss of well control events are recoverable and result in no environmental releases.

Despite a mixed assessment of BOP effectiveness over the last 12 years, this Agency had made no changes in regulation for BOP's in the face of such ambiguous results. The need for redundant well control systems was recognized and judged desirable in TA&R studies. The TA&R studies conclude that the failure rate for surface BOP's was worse than for subsea BOP's (Tetrahedron, Inc., 1996) but that both types of units approached 50 percent failure rates in effectiveness studies. No TA&R study was carried out under strictly controlled conditions that simultaneously accounted for different BOP ram types, rig mount locations, the metallurgy and thickness of casing steel, or deepwater pressure and temperature conditions.

The new post-DWH event safety requirements put in place on October 14, 2010 (*Federal Register*, 2010b), included several added regulations to improve the safety of well control systems. (**Chapter 1.3.1**). These regulations include the following: (1) seafloor function testing of ROV intervention and deadman systems—30 CFR 250.516(d), 30 CFR 250.616(h), and 30 CFR 250.449(j) and (k); (2) third-party certification that the shear rams will shear drill pipe under maximum anticipated pressure—30 CFR 250.416(e); (3) registered professional engineer certification that the well design is appropriate for expected wellbore conditions—30 CFR 250.420(a); (4) use of dual mechanical barriers for the final casing string—30 CFR 250.420(b); (5) negative pressure testing of individual casing strings—30 CFR 250.423(c); and (5) retrieval and testing of BOP after a shear ram has been activated in a well control situation—30 CFR 250.451(i).

The BOEMRE released NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," effective November 8, 2010, to address the use of BOP's and well containment resources in the aftermath of the DWH event. The NTL only applies to operators using BOP's subsea or at the surface on floating facilities. It explains that lessees and operators submit a statement signed by an authorized company official with each application for a well permit, indicating that they will conduct all of their authorized activities in compliance with all applicable regulations, including the Increased Safety Measures Regulations (*Federal Register*, 2010b). The NTL also informs lessees that BOEM will be evaluating whether or not each operator has submitted adequate information demonstrating that it has access to and can deploy surface and subsea containment resources that would be adequate to promptly respond to a blowout or other loss of well control. The NTL does not require that operators submit revised OSRP's that include this containment information at this time. The operator was notified of BOEM's intention to evaluate the adequacy of each operator's capability to comply in the operator's current OSRP; therefore, there is an incentive for voluntary compliance. The type of information that BOEM will review pursuant to this NTL includes, but is not limited to,

- subsea containment and capture equipment, including containment domes and capping stacks;
- subsea utility equipment, including hydraulic power, hydrate control, and dispersant injection equipment;
- riser systems;
- remotely operated vehicles;
- capture vessels;
- support vessels; and
- storage facilities.

3.2.3. Pipeline Failures

Significant sources of damages to OCS pipeline infrastructure are mass sediment movements and mudslides that can exhume or push the pipelines into another location, impacts from anchor drops or boat collisions, and accidental excavation or breaching because the exact whereabouts of a pipeline are uncertain.

The uncertain location of pipelines is an ongoing safety and environmental hazard. On October 23, 1996, in Tiger Pass, a channel through the Mississippi River Delta into the Gulf of Mexico near Venice, Louisiana, the crew of the Bean Horizon Corporation dredge *Dave Blackburn* dropped a stern spud (a large steel shaft that is dropped into the river bottom to serve as an anchor and a pivot during dredging operations) into the bottom of the channel in preparation for continued dredging operations. The spud struck and ruptured a 12-in (30-cm) diameter, submerged natural gas steel pipeline owned by Tennessee Gas Pipeline Company. The pressurized natural gas (about 930 psig) released from the pipeline enveloped the stern of the dredge and an accompanying tug, the *G.C. Linsmier*. Within seconds of reaching the surface, the natural gas ignited. The resulting fire destroyed the dredge and the tug. Twenty-eight crew members from the dredge vessel and tug boat abandoned ship or boarded nearby vessels (USDOT, National Transportation Safety Board, 1998). A description of the incident in a National Transportation and Safety Board safety recommendation (USDOT, National Transportation Safety Board,

1998) indicates that lack of awareness of the precise location of the pipeline was a major contributing factor to this accident.

On December 5, 2003, this Agency received an incident report that a cutterhead dredge barge ruptured a 20-in (51-cm) diameter condensate pipeline in Eugene Island Block 39. Dredging operations by COE were taking place in Atchafalaya Channel. No injuries were reported, but a small condensate spill and subsequent fire damaged the dredge barge. The incident was apparently caused by inaccurate knowledge of the pipeline's location. The global positioning system beacon was located on the barge tug rather than on the bow of the dredge barge where the suction cutterhead operated. Therefore, the true position of the pipeline relative to the suction cutterhead was in error by at least the length of the dredge barge (about 400 ft; 121 m). Lack of awareness of the precise location of the pipeline was the major contributing factor to this accident as well.

Following the 2004, 2005, and 2008 hurricane seasons, this Agency commissioned studies to examine the failure mechanisms of offshore pipelines (Atkins et al., 2007; Energo Engineering 2010; Atkins et al., 2006). **Table 3-24** shows pipelines damaged after the 2004-2008 hurricanes passing through the CPA and WPA. Much of the reported damage is riser or platform-associated damage, which typically occurs when a platform is toppled or otherwise damaged.

Table 3-25 shows the hurricane-associated spills from pipelines >50 bbl. The largest spills are typically due to pipeline movements, mudslides, anchor drops, and collisions of one type or another. Most pipeline damage occurs in shallow (<200 ft; 61 m) water because of the potential for increasing impacts of the storm on the seabed in shallow water, the relative density of pipelines, or the age and design standards of the pipeline or the platforms to which the pipelines are connected.

The future impact of hurricanes on damage to pipelines is uncertain. As oil production shifts from shallow to deeper water, there may be a consolidation of pipeline utilization.

An OCS-related spill ≥1,000 bbl would likely be from a pipeline accident; the median spill size is estimated to be 2,200 bbl for rig/platform and pipeline activities supporting a proposed action (**Table 3-12)**. For both the WPA and CPA proposed actions, up to one spill of this size is estimated to occur."

3.2.4. Vessel Collisions

This Agency revised operator incident reporting requirements in a final rule effective July 17, 2006 (*Federal Register*, 2006c). The new incident reporting rule more clearly defines what incidents must be reported, broadens the scope to include incidents that have the potential to be serious, and requires the reporting of standard information for both oral and written reports. As part of the incident reporting rule, this Agency's regulations at 30 CFR 250.188(a)(6) requires an operator to report all collisions that result in property or equipment damage greater than $25,000. "Collision" is defined as the act of a moving vessel (including an aircraft) striking another vessel, or striking a stationary vessel or object (e.g., a boat striking a drilling rig or platform).

This Agency's data show that, from 1996 to 2010, there were 234 OCS-related collisions. Most collision mishaps are the result of service vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10 percent of vessel collisions with platforms in the OCS caused diesel spills. Fires resulted from hydrocarbon releases in several of the collision incidents. To date, the largest diesel spill associated with a collision occurred in 1979 when an anchor-handling boat collided with a drilling platform in the Main Pass leasing area, spilling 1,500 bbl. Diesel fuel is the product most frequently spilled, while oil, natural gas, corrosion inhibitor, hydraulic fluid, and lube oil have also been released as the result of a vessel collision. Human error accounts for approximately half of all reported vessel collisions from 2006 to 2010.

Safety fairways, traffic separation schemes, and anchorages are the most effective means of preventing vessel collisions with OCS structures. In general, fixed structures such as platforms and drilling rigs are prohibited in fairways. Temporary underwater obstacles, such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs, may be placed in a fairway under certain conditions. A limited number of fixed structures may be placed at designated anchorages. The USCG's requirements for indicating the location of fixed structures on nautical charts and for lights, sound-producing devices, and radar reflectors to mark fixed structures and moored objects also help minimize the risk of collisions. In addition, the USCG 8th District's Local Notice to Mariners (monthly editions and weekly supplements) informs GOM users about the addition or removal of drilling rigs and platforms, locations of aids to navigation, and defense operations involving temporary moorings. Marked platforms often become aids to navigation for vessels (particularly fishing boats and vessels supporting offshore oil and gas operations) that operate in areas with high densities of fixed structures.

The National Offshore Safety Advisory Committee (NOSAC, 1999) examined collision avoidance measures between a generic deepwater structure and marine vessels in the GOM. The NOSAC offered three sets of recommendations: (1) voluntary initiatives for offshore operators; (2) joint government/ industry cooperation or study; and (3) new or continued USCG action. The NOSAC (1999) proposes that oil and gas facilities be used as aids-to-navigation because of their proximity to fairways, fixed nature, well-lighted decks, and inclusion on navigational charts. Mariners intentionally set and maintain course toward these facilities, essentially maintaining a collision course. Unfortunately, most deepwater facilities do not install collision avoidance radar systems to alert offshore facility personnel of a potentially dangerous situation. The NOSAC estimates that 7,300 large vessels (tankships, freight ships, passenger ships, and military vessels) pass within 35 mi (56 km) of a typical deepwater facility each year. This estimate resulted in approximately 20 transits per day for the 13 deepwater production structures existing in 1999. The NOSAC found the total collision frequency to be approximately one collision per 250 facility-years (3.6×10^{-3} per year). The NOSAC estimated that, if the number of deepwater facilities increases to 25, the estimated total collision frequency would increase to one collision in 10 years. A cost-benefit analysis within the report did not support the use of a dedicated standby vessel for the generic facility; however, the analysis did support the use of a radar system on deepwater facilities if the annual costs of the system were less than or equal to $124,500.

The OCS-related vessels could collide with marine mammals, turtles, and other marine animals during transit. To limit or prevent such collisions, NMFS provides all boat operators with "Whalewatching Guidelines," which is derived from the Marine Mammal Protection Act. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. The frequency of vessel collisions with marine mammals, turtles, or other marine animals probably varies as a function of spatial and temporal distribution patterns of the living resources, the pathways of maritime traffic (coastal traffic is more predictable than offshore traffic), and as a function of vessel speed, the number of vessel trips, and the navigational visibility.

To prevent any further incidents in regard to collisions with submerged or destroyed platforms following Hurricanes Katrina and Rita, in December 2005, BOEMRE published a safety alert that provided the location of all facilities that were destroyed during the storms.

3.2.5. Chemical and Drilling-Fluid Spills

The BOEM and USCG categorize spill volumes using different units. The BOEM works in barrels while USCG works in gallons.

Minor	Medium	Major
<238 bbl (<10,000 gal)	238-2,380 bbl (10,000-99,999 gal)	≥2,381 bbl (100,000 gal)

1 bbl = 42 U.S. gallons.

Chemical Spills

Chemicals are stored and used to condition drill muds during production and in well completions, stimulation, and workover procedures. The relative quantity of their use is reflected in the largest volumes spilled. Completion fluids are the largest quantity used and are the largest accidental releases. The most common chemicals spilled are methanol, ethylene glycol, and zinc bromide. Additional production chemicals are needed in deepwater operations where gas hydrates tend to form. The volumes spilled during each event are anticipated to remain about the same, but spill frequency can be expected to improve because of advances in subsea processing.

A study of chemical spills from OCS activities determined that only two chemicals could potentially impact the marine environment—zinc bromide and ammonium chloride (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and, therefore, are not in continuous use. Most other chemicals are either nontoxic or used in small quantities.

Zinc bromide is of particular concern because of the toxic nature of zinc. The study modeled a spill of 45,000 gallons of a 54-percent aqueous solution, which would result in an increase in zinc concentrations to potentially toxic levels. Direct information on the toxicity of zinc to marine organisms is not available; however, the toxicity of zinc to a freshwater crustacean (*Ceriodaphnia dubia*) indicated that exposure to 500 ppb zinc results in measurable effects. One factor not considered in the model is the rapid precipitation of zinc in marine waters, which would minimize the potential for impact.

Ammonium chloride was modeled using potassium chloride as a surrogate. The model looked at a spill of 4,717 kilograms (10,399 pounds) of potassium chloride powder. The distribution of potassium would overestimate the distribution of ammonia released during a spill. The model indicated that, close to the release point, ammonia concentrations could exceed toxic levels for time scales of hours to days. Additional information on the degradation of ammonia in seawater would be needed for a more complete evaluation.

In a study of sublethal effects of production chemicals on fish associated with platforms, the simultaneous exposure to methanol and ethylene glycol had a greater effect than exposure to either chemical alone. Swimming performance was the outcome studied (Baltz and Chesney, 2005).

Hurricanes Gustav and Ike in 2008 caused an increase in the number of chemical spills. In 2008, there were 32 chemical spills; 22 of those spills occurred because of Hurricane Ike on September 13, 2008. The largest spill was a 713-bbl spill of calcium chloride brine (USDOI, BOEMRE, 2010f). See **Tables 3-26** for additional information about chemical spills ≥1,000 bbl.

Synthetic-based Fluid Spills

Synthetic-based fluids (SBF's) or muds (SBM) have been used since the mid 1990's. In deepwater drilling, SBF's are preferred over water-based muds because of the SBF's superior performance properties. The synthetic oils used in SBF's are relatively nontoxic to the marine environment and have the potential to biodegrade. Five SBF spills of ≥1,000 bbl occurred between 2001 and 2009 (**Table 3-26**). Originally, the entire volume of the spill was recorded. However, the volume of the synthetic portion of the drill fluid rather than the total volume of the drill fluid is now used to describe spill size. Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when SBF's are in use. Each of the five releases occurred as a result of unplanned riser disconnect or failure. The rate is expected to decrease in the future because each accident is investigated, the cause is determined and publicized, and improvements are made.

In 2007, a SBF spill of 1,061 bbl occurred in Green Canyon Block 726. A crack in a joint on the riser was the cause of the spill (USDOI, BOEMRE, 2010g). In 2008, an SBF spill of 1,718 bbl occurred in Mississippi Canyon Block 941 because of a valve not closing properly (USDOI, BOEMRE, 2010f). See **Tables 3-26** for additional information about chemical spills ≥1,000 bbl.

3.3. CUMULATIVE ACTIVITIES SCENARIO

3.3.1. OCS Program

The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the 40-year activity period. Projected reserve/resource production for the OCS Program (**Table 3-1**; WPA, CPA, and EPA) is 18.34-25.64 Bbbl of oil and 75.886-111.627 Tcf of gas. **Tables 3-2 through 3-6** present projections of the major activities and impact-producing factors related to future Gulfwide OCS Program activities

The level of OCS activity is connected to oil prices, resource potential, cost of development, and rig availability rather than just, or even primarily to, the amount of acreage leased. The impacts of activities associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the cumulative impacts analysis sections of **Chapter 4**.

Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action, i.e., a typical sale that would result from a proposed lease sale within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA will be disclosed in a subsequent EIS.

3.3.2. State Oil and Gas Activity

All of the five Gulf Coast States have had some historical oil and gas exploration activity, and with the exception of Florida and Mississippi, all currently produce oil and gas in State waters. The coastal infrastructure that supports the OCS Program also supports State oil and gas activities.

State oil and gas infrastructure consists of the wells that extract hydrocarbon resources, facilities that produce and treat the raw product, pipelines that transport the product to refineries and gas plants for further processing, and additional pipelines that transport finished product to points of storage and final consumption. The type and size of infrastructure that supports production depends upon the size, type, and location of the producing field, the time of development, and the life cycle stage of operations.

Texas

The first offshore well in Texas was drilled in 1938, but the first oil discovery was not made until 1941 off of Jefferson County. The Railroad Commission of Texas is the agency charged by the Texas Legislature with the regulation of the oil and gas industry in the State of Texas. According to the Texas Railroad Commission, the peak year for crude oil production in the entire State was 1972, when 167,223 wells produced nearly 1.26 BBO (Railroad Commission of Texas, 2010). As of 2007, production had ebbed to 336 million bbl of oil. In 2008, production increased for the first time since 1991 to more than 346 million bbl of oil, before falling in 2009 (Austin-American Statesman, 2010). Between January and December 2009, production in the State's offshore areas for the 11 contiguous coastal counties of Texas yielded 229,984 bbl of oil and 85.9 MMcf of gas (**Table 3-27**).

The Lands and Minerals Division of the Texas General Land Office (TGLO) holds lease sales for oil and gas on State lands, and TGLO manages Texas State resources for the benefit of public education. The TGLO holds sales quarterly in January, April, July, and October. Because of holidays, sales are usually held on the first Tuesday of the month in January and July. Nominations for a sale are due 2 weeks after the previous sale date (e.g., nominations for the July sale would be due 2 weeks following the date of the April sale).

The TGLO developed the Energy Land and Lease Inventory System (TGLO, 2010) as an Internet mapping application that provides the public with land and lease information about State-owned submerged lands. Because the Energy Land and Lease Inventory System is a tool and not the formal notification, prospective bidders should refer to the Notice for Bids and addenda to obtain the marginal number and minimum bid of the tract that they wish to bid upon for an upcoming oil and gas lease sale because the Notice for Bids and addenda are controlling. The TGLO Mineral Leasing Division uses a sealed bid process for the leasing of State lands.

The most recent oil and gas lease sale occurred on April 21, 2010. Two hundred and sixty-one (261) parcels, containing 102,426 ac (41,450 ha), of State lands were offered for oil and gas leasing by Texas State University Lands (Digital Petrodata, 2010). The number of acres offshore was unspecified.

The BOEM expects that Texas will conduct regular oil and gas lease sales during the 40-year cumulative activities scenario for OCS activity, although the sales' regularity could differ from current practices.

Louisiana

Louisiana has been the second most important oil- and gas-producing state after Alaska. Oil production in Louisiana began in 1902, with the first oil production in the coastal zone in 1926. The State of Louisiana issued its first offshore oil and gas lease in 1936, and in 1937 the Pure Oil Company discovered the first Louisiana oil field 1.2 mi (1.9 km) offshore of Cameron Parish using a platform built on timber pilings in water 15 ft (4.6 m) deep. Most oil is produced in southern Louisiana and most gas is produced in northern Louisiana.

The nine contiguous parishes of the coastal zone produced more than 50 percent of the State's oil during the 1950's. Oil production peaked at 513 million bbl in 1970 and gas production peaked at 7.8 MMcf in 1969 (Ko and Day, 2004a, p. 398). For the nine contiguous coastal zone parishes in 2009, the Louisiana Dept. of Natural Resources' SONRIS lite database (Louisiana Dept. of Natural Resources, 2010) showed a total of 4,266 producing wells, 43 million bbl of oil production, and 0.43 MMcf of gas production (**Table 3-28**).

Louisiana's leasing procedure is carried out by the Petroleum Lands Division of the Office of Mineral Resources and proceeds along the following procedural steps (McKeithen, 2007): (1) industry nominates acreage for leasing every month (By law, nominated tracts cannot exceed 5,000 ac [2,023 ha], but by Mineral Board policy, the size limit of a nominated tract is further limited to only 2,500 ac [1,012 ha].); (2) the nominated tracts are then advertised in official State and parish journals; (3) competitive, sealed bidding then takes place on bonus, royalty, and rental to be received by the State (The sealed bids are opened and read into the record at a public meeting of the Louisiana Mineral Board at the time and place advertised.); and (4) if it determines that the bids are sufficient, the Louisiana Mineral Board awards the leases to the highest bidder after evaluating data provided from the staff geologists from the Geology and Engineering Division of the Office of Mineral Resources. The term of the lease is limited to 3 years for inland tracts and 5 years for offshore tracts.

The most recent oil and gas lease sale occurred on August 10, 2011. Thirty-nine leases containing 44,000 ac (17,807 ha) of State lands were offered for oil and gas leasing by the Office of Mineral Resources on behalf of the State Mineral Board for Louisiana (Digital Petrodata, 2011). The number of acres offshore was unspecified. The BOEM expects that Louisiana will conduct regular oil and gas lease sales during the 40-year cumulative activities scenario for OCS activity, although their regularity could differ from current practices.

Pipeline Infrastructure

The existing pipeline network in the Gulf Coast States is the most extensive in the world and has unused capacity (USDOI, MMS, 2007a, p. 4-63). The network carries oil and gas onshore and inland to refineries and terminals, and a network of pipelines distribute finished products such as diesel fuel or gasoline to and between refineries and processing facilities onshore (Peele et al., 2002, Figure 4.1). Expansion of this network is projected to be primarily small-diameter pipelines to increase the interconnectivity of the existing network and a few major interstate pipeline expansions. Any new larger-diameter pipelines would likely be constructed to support onshore and offshore LNG terminals. However, as discussed in **Chapter 3.3.3**, there is spare capacity in the existing pipeline infrastructure to move regasified natural gas to market, and deepwater ports can serve onshore facilities including intrastate as well as interstate pipelines.

Texas

There are 69 OCS-related pipelines that transition into Texas State lands or make landfall onshore (**Figure 3-5**). The Railroad Commission of Texas reports that there are slightly over 150,000 mi (242,402 km) of petroleum-product-carrying intrastate pipelines, but no differentiation was provided for the length of pipeline in the 11 coastal counties contiguous to the GOM (Railroad Commission of Texas, 2009, p. 79).

Johnston et al. (2009) determined that annual rates of landloss within 150 m (492 ft) to either side of OCS-related pipelines were highest in the Louisiana delta plain and intermediate in the Texas coastal plain. The higher wetland loss rates for the Louisiana delta plain (eastern part of the LCA) are explained, at least in part, by the high density of pipelines located there, the relatively large number of open pipeline canals, and high rates of subsidence, coupled with reduced riverine sediment input (Johnston et al., 2009, p. 5). Lower wetland loss rates for the Texas barrier islands can be explained, at least in part, by the use of more environmentally friendly construction methods (e.g., directional drilling and push-pulling with backfilling mitigation) in sensitive environments. Trends in habitat change within the immediate vicinity of OCS-related pipelines were minor in the Texas, but significant in Louisiana. In Louisiana, open water increased while non-fresh marsh decreased (Johnston et al., 2009, p. 6). Unlike the Mississippi Delta and LCA, the Texas coastal plain is not part of one large deposition system that drains much of the North American continent. Landlosses from subsidence caused by compaction of young, muddy sediment is not as important an impacting factor on the Texas coastal plain and barrier islands.

Coastal wetland loss results from a combination of natural processes such as subsidence, sea-level rise, storms, and barrier island degradation, combined with human-induced factors such as agriculture, OCS or State oil and gas infrastructure, industrial development, and urban and suburban sprawl (U.S. Dept. of the Army, COE, 2004a; Jacob et al., 2006).

In Texas, it is estimated that 9.5 percent of estuarine wetlands have been lost between the mid-1950's through the early 1990's, with similar decreases in forested wetlands (10.9%) and freshwater wetlands (4.3%) (Moulton et al., 1997).

Louisiana

There are currently 109 OCS-related (pipelines that have at one time or another carried hydrocarbon product from the OCS) pipeline landfalls in the LCA (**Table 3-13**). Included in that figure is a subset of 47 pipeline systems under DOT jurisdiction; these systems originate in Federal waters and terminate onshore or in Louisiana State waters (Gobert, 2010) (**Figure 3-5**).

Pipelines that are constructed to serve the OCS and that are located in the LCA between now and 2046 could result in direct impacts by displacing wetlands, but new construction would likely be along existing pipeline corridors and emplaced under wetlands using amphibious vehicles and required route backfilling. Pipelines International (2010) explained the procedures recently used by builders of a 30-in-diameter onshore pipeline in near Hackberry, Louisiana, and a 24-in-diameter pipeline near Lottie, Louisiana. The following 10 steps for modern pipeline construction in wetlands used for the 30-in-diameter pipeline were explained (Pipelines International, 2010):

(1) move in equipment and personnel to establish and prepare right-of-way for continuous access;

(2) identify and mark sensitive areas;

(3) determine logistics for pipe, material, and personnel movement;

(4) backhoe equipment trenches a ditch with sufficient depth and width to accommodate pipe installation;

(5) crews perform welding, coating, and quality control functions and then install sufficient floats for buoyancy purposes;

(6) equipment then guides different sections into final position before removing floats;

(7) equipment and personnel are dispatched to remote locations to weld all sections in advance of backfilling;

(8) after substantial backfill and all welding is completed, the entire line is subjected to hydrostatic testing to confirm suitability for intended use;

(9) after hydrotest, tie-ins are completed; and

(10) final cleanup and restoration, and move out construction equipment and personnel.

WPA and CPA Proposed Actions Scenario (Typical Sale): As reported is **Chapter 3.1.2.1.6** for the WPA and CPA proposed actions, 0-1 new landfalls are projected. Any pipeline built as the result of a proposed action is most likely to be a subsea tie-in located in State waters; therefore, landloss projected to result from pipeline installations is not anticipated. New pipelines that landfall now call for mitigations that result in "no net loss" of wetland, no new direct wetland losses are projected over the cumulative activities scenario from OCS-related pipeline construction.

OCS Program Cumulative Scenario: Pipeline landfalls in the GOM peaked in the 1970's (**Figure 3-5**. The total length of OCS-related pipeline built would be partially based on future OCS leasing activity. For the OCS Program between the years 2012 and 2051, a range of 1,967-4,128 km (1,221-2,565 mi) of pipeline are projected to be built in the WPA and 8,515-16,993 km (5,291-10,559) in the CPA in water depths of ≤60 ft (18 m). This estimate does not include pipeline length in Texas State waters inshore of 9 nmi (10 mi; 16 km).

3.3.3. Other Major Factors Influencing Offshore Environments

Natural and man-caused influencing factors occur in the offshore areas of Gulf States while OCS activity takes place at the same time. Some of these factors are (1) dredged material disposal, (2) OCS sand borrowing, (3) marine transportation, (4) military activities, (5) artificial reefs and rigs-to-reefs development, (6) offshore LNG projects, (7) development of gas hydrates, and (8) renewable energy and alternative use.

3.3.3.1. Dredged Material Disposal

Materials from maintenance dredging are primarily disposed of offshore on existing dredged-material disposal banks and in ocean dredged-material disposal sites (ODMDS), which are regulated by USEPA. Additional dredged-material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by COE and relevant State agencies prior to construction.

If funds are available, dredged materials disposed offshore are available for potential beneficial uses to restore and create habitat, beach nourishment projects, and industrial and commercial development; a use called the beneficial use of dredge materials program by COE (**Chapter 3.3.4.3**). Virtually all ocean dumping that occurs today is maintenance dredging of sediments from the bottom of channels and waterbodies in order to maintain adequate channel depth for navigation and berthing. There are four small ODMDS's offshore Louisiana and Mississippi along open-water stretches of the main GIWW between Louisiana and Mississippi: in Louisiana ODMDS 66 (1,593 ac; 645 ha); and in Mississippi ODMDS 65A (1,962 ac; 794 ha), 65B (815 ac; 330 ha), and 65C (176 ac; 71 ha) (U.S. Dept of the Army, COE, 2008, Table 1). Dredged materials from GIWW are sidecast at these ODMDS locations. The ODMDS's utilized by COE in the cumulative activities area include those shown in **Table 3-29**. Maps show the locations for the ODMDS's in Louisiana and Texas (USEPA and U.S. Dept. of the Army, COE, 2003, Appendix D).

The COE's Ocean Disposal Database reports the amount of dredged material disposed in ODMDS's by district (U.S. Dept. of the Army, COE, 2011a). **Table 3-30** shows the quantities of dredged materials disposed of in ODMDS between 2000 and 2009 by the Galveston and New Orleans Districts.

Current figures vary for how much of the average annual 70 million yd^3 (53,518,840 m^3) that is dredged by the New Orleans District is available for the beneficial use of dredge materials program; from 15 million yd^3 (11,468,320 m^3) (U.S. Dept. of the Army, COE, 2009a, p. 26) to 30 million yd^3 (22,936,650 m^3) (Green, 2006, p. 6), or between 21 and 43 percent of the total. The remaining 79 to 57 percent of the total material dredged yearly by COE New Orleans District is disposed of in ODMDS's or is stored in temporary staging areas located inland (e.g., the Pass a Loutre Hopper Dredge Disposal Site at the head of the Mississippi River's main "birdfoot" distributary channel system).

Cumulative Activities Scenario: The BOEM anticipates that over the next 40 years the amount of dredged material disposed at ODMDS's will fluctuate generally within the trends established by the Galveston and New Orleans Districts. The Galveston District has averaged about 6 million yd^3 of material dredged per year and the New Orleans District has averaged about 22 million yd^3 of material dredged per year disposed at ODMDS's over the last 10 years. Quantities may decrease slightly as more beneficial uses of dredged material onshore are identified. The 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention), to which the U.S. is a signatory, requires annual reporting of the amount of materials disposed at sea. The COE prepares the dredged material disposed portion of the report to the International Maritime Organization, the yearly reports for which are posted on COE's Ocean Disposal Database (U.S. Dept. of the Army, COE, 2011b).

3.3.3.2. OCS Sand Borrowing

If OCS sand is desired for coastal restoration or beach nourishment, BOEM uses the following two types of lease conveyances: a noncompetitive negotiated agreement that can only be used for obtaining sand and gravel for public works projects funded in part or whole by a Federal, State, or local government agency; and a competitive lease sale in which any qualified person may submit a bid. The BOEM has issued 31 noncompetitive negotiated agreements, but it has never had a competitive lease sale for OCS sand and gravel resources. The OCS Program continues to focus on identifying sand resources for coastal restoration, investigating the environmental implications of using those resources, and processing noncompetitive use requests.

This Agency has participated in the multiagency Louisiana Sand Management Working Group since 2003 to identify, prioritize, and define a pathway for accessing sand resources in the near-offshore OCS of Louisiana, an area where competitive space use mainly involves OCS oil and gas infrastructure such as wells, platforms, and pipelines. **Table 3-31** shows the projected OCS sand uses for coastal restoration projects over approximately the next 5 years. Approximately 76 million yd^3 are expected to be needed for coastal restoration projects as reported by the Gulf of Mexico OCS Region's Marine Minerals Program. To visualize such a dimension, this volume of sand could fill the Louisiana Superdome stadium 16.5 times.

This Agency received earmarked funds in 2005 to conduct offshore sand studies to investigate available sources of OCS sand for restoring coastal areas in Louisiana, Texas, Alabama, and Mississippi that were damaged by Hurricanes Katrina and Rita. Sand sources identified through this Agency's cooperative effort with Louisiana will likely serve as the major source of material for the restoration of the barrier islands planned as part of the LCA ecosystem restoration study (U.S. Dept. of the Army, COE, 2004b). The Louisiana Office of Coastal Protection and Restoration and Louisiana State University have undertaken joint efforts, funded in part through BOEM, to identify potential sand resources in the Trinity and Tiger Shoal complex, located in the Vermilion and South Marsh Island leasing areas, and to examine the long-term effects of dredging sand on Ship Shoal, a large potential borrow area about 15 mi (24 km) offshore Isle Dernieres, south-central Louisiana. Meanwhile, the General Lands Office in Texas is collecting new geologic and geophysical data to describe potential resources in buried Pleistocene Sabine and Colorado River paleochannels, located offshore Jefferson and Brazoria Counties.

Since the dredging of OCS sand and the associated activities of oceangoing dredge vessels could present some use conflicts on blocks also leased for oil and/gas extraction, this Agency initiated a regional offshore sand management program in Louisiana in 2003, which, over the course of 8 years and several meetings, has developed options and recommendations for an orderly process to manage the competing use of OCS sand resources in areas of existing OCS infrastructure. With input from the Sand Management Working Group, BOEM has developed guidelines for sand resource allocations, maintaining a master schedule of potential sand dredging projects, developing procedures for accessing sand under emergency conditions, and establishing environmental requirements for the use of offshore borrow areas.

No sand leases have ever been issued for OCS sand in the WPA. The following five leases for OCS sand have been issued in the CPA: (1) Holly Beach, Cameron Parish, Louisiana; (2) the South Pelto test area, Terrebonne Parish, Louisiana; (3) Pelican Island shoreline restoration, Plaquemines Parish, Louisiana; (4) Raccoon Island marsh creation, Terrebonne Parish, Louisiana; and (5) St. Bernard Shoals, St. Bernard and Plaquemines Parishes, Louisiana. Two new leases are expected to be issued in 2012 for Cameron Parish shoreline restoration in Cameron Parish, Louisiana, and for Caminada Headland shoreline restoration in Lafourche and Jefferson Parishes, Louisiana.

The NTL 2009-G04 identifies BOEM's responsibility as stewards of significant sand resources on the OCS and provides guidance for the avoidance and protection of significant OCS sediment resources essential to coastal restoration initiatives in the BOEM Gulf of Mexico OCS Region.

Cumulative Activities Scenario: Over the next 40 years, great uncertainty exists regarding OCS sand mining projects in the WPA. The boundary between the OCS and Texas State waters (9 nmi [10 mi; 16 km]) allows that some offshore sand is within the jurisdiction of the State; however, the easternmost portion of the shelf in Texas State waters is relatively devoid of beach-quality sand deposits. The Texas General Lands Office, in cooperation with BOEM and Texas Bureau of Economic Geology, has investigated the potential for use of Heald and Sabine Banks as borrow for beach restoration projects; however, no specific projects have been identified. Some uncertainty exists for how much OCS sand offshore the State of Louisiana will eventually be sought. The Louisiana Coastal Area Ecosystem Restoration plan potentially may use up to 60 million yd^3; however, State/Federal cost-sharing agreements and Federal funding levels for project design and construction is uncertain (U.S. Dept. of the Army, COE, 2009b, Figures 17-1, 17-2, and 17-3). There has been a recent increase in State-funded projects in Louisiana requesting OCS sand resources. It is anticipated that this trend of State-led projects will continue into the future as restoration funding is made available directly to the State through the Coastal Impact Assistance Program (CIAP), restitution (i.e., fines and penalties, associated with the DWH event), and the GOMESA.

3.3.3.3. Marine Transportation

Freight and cruise ship passenger marine transportation within the analysis area should continue to grow at a modest rate or remain relatively unchanged based on historical freight traffic statistics under current conditions. The Port of New Orleans was the sixth largest port in the United States in terms of tonnage handled in 2008. Tankers carrying mostly petrochemicals account for about 40 percent of the vessel calls. Dry-bulk vessels carrying coal, coke, grain, etc., account for another 40 percent of vessel calls. New Orleans is a popular port for cruises. The Port of New Orleans supports year-round operations at the Julia Street and Erato Street cruise terminals that, in 2009 and 2010, saw 101 and 89 cruise ship departures, respectively (USDOT, MARAD, 2011a).

Trends for use of all Gulf Coast ports show an increase from 31.2 to 34.1 percent of total U.S. port use (USDOT, MARAD, 2009) between 2004 and 2009 (**Table 3-32**), an increase of about 3 percent over the past decade. The estimated number of vessel trips that would occur as a result of a WPA and CPA proposed action is presented in **Tables 3-2 and 3-3**. Use by the OCS Program represents a small percentage of the total marine transportation in the GOM, <1 percent of reported usage for Federal channels (**Chapter 3.1.1.4.4**).

Cumulative Activities Scenario: The BOEM anticipates that, over the next 40 years, the total amount of Gulf Coast port usage will be bounded by a lower limit of the approximate levels of current use and a higher limit consisting of a steady increase of approximately 3 percent each decade.

3.3.3.4. Military Activities

The WPA includes all or parts of the following military warning areas: W-147, W-228, and W-602.

The air space over the WPA is used by the DOD for conducting various air-to-air and air-to-surface operations. Twelve military warning areas and six Eglin Water Test Areas are located within the Gulf (**Figure 2-2**). These warning and water test areas are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years. Several military stipulations are planned for leases issued within identified military areas.

Naval Mine Warfare Command Operational Area D contains 17 blocks in the WPA and is used by the Navy for mine warfare testing and training. In addition to Naval Mine Warfare Command Operational Area D, the WPA has four warning areas that are used for military operations. The areas total approximately 21.3 million ac or 75 percent of the total acreage of the WPA. To eliminate potential impacts from multiple-use conflicts on the aforementioned area and on blocks that the U.S. Dept. of the Navy has identified as needed for testing equipment and for training mine warfare personnel, a standard Military Areas Stipulation is routinely applied to all GOM leases in the WPA and CPA. That stipulation includes the following provisions:

- *Hold and Save Harmless*: Lessee assumes all risks of damage or injury to persons or property in connection with activity performed by the lessee.
- *Electromagnetic Emissions*: Lessee agrees to control its own electromagnetic emissions and must coordinate with appropriate military installation command headquarters.
- *Operational*: Lessee must enter into an agreement with the appropriate military command headquarters prior to commencing any activities in designated warning and water test areas).

In addition, for many years, the BOEM's Gulf of Mexico OCS Region has reminded lessees and designated operators of their obligation to enter into this agreement and provided the address and telephone number of the appropriate military command headquarters each time an Exploration Plan (EP), Development Operations Coordination Document (DOCD), or lease-term pipeline application was approved for activities on OCS leases that contained the stipulation. Effective January 27, 2004, the BOEM's Gulf of Mexico OCS Region no longer provided these lease stipulation reminders in each individual EP, DOCD, or lease-term pipeline approval letter. Instead, NTL 2004-G02, "Military Warning and Water Test Areas," was issued to serve that purpose.

Within the CPA, wholly or partially, lie six designated military areas and three Eglin Water Test Areas (EWTA's) that are used for military operations (**Figure 2-2**). The military warning areas within the CPA total approximate 13.3 million ac (about 23% of the total acreage of the CPA). The EWTA's within the CPA total approximately 7 million ac (about 12% of the total acreage of the CPA). In addition to the previously noted standard Military Areas Stipulation, the EWTA will require the following special stipulations:

- *Evacuation Stipulation*: Lessee is required to evacuate, upon receipt of a directive from the BOEM Regional Director, all personnel from structures on the lease. Lessee must also shut-in and secure all wells and other equipment, including pipelines, on the lease.
- *Coordination Stipulation*: Lessee is required to consult with the appropriate military command headquarters regarding the location, density, and the planned periods of operation of surface structures on the lease, and to maximize exploration while minimizing conflicts with DOD activities prior to approval of an exploration plan by the BOEM Regional Director.

Finally, given that all of the available CPA acreage identified for leasing consideration within this EIS is west of the critical military mission zone of Eglin Air Force Base (i.e., a zone to the west of 86˚41' W. longitude), no additional stipulations to those previously identified for EWTA blocks will be needed.

Cumulative Activities Scenario: The BOEM anticipates that, over the next 40 years, the military use areas currently designated in the WPA and CPA will remain the same and that none of them would be released for nonmilitary use. Over the cumulative activities scenario, BOEM expects to continue to require military coordination stipulations in these areas. The intensity of the military's use of these areas, or the type of activities conducted in them, is anticipated to fluctuate with the military mission needs.

3.3.3.5. Artificial Reefs and Rigs-to-Reefs Development

Artificial reefs have been used along the coastline of the U.S. since the early 19th century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish but, in some instances, also enhance the production of fish. All of the five Gulf Coast States—Texas, Louisiana, Mississippi, Alabama, and Florida—have artificial reef programs and plans.

Most OCS platforms have the potential to serve as artificial reefs. Offshore oil and gas platforms began providing artificial reef substrate in the GOM with the first platform's installation in 1942. Historically, approximately 9 percent of the platforms decommissioned in the Gulf OCS have been used in the Rigs-to-Reefs Program. It is anticipated that approximately 10 percent of platforms installed as a result of a WPA or CPA proposed action would be converted to a reef after decommissioning. This factor is prompting increased public attention on the ecologic value of oil and gas structures for their reef effects. Ongoing studies aim at evaluating the ecology of offshore structures and may lead to a greater emphasis on creation of artificial reefs through the Rigs-to-Reefs Program. At present, Texas, Louisiana, and Mississippi participate in the Rigs-to-Reefs Program.

WPA and CPA Proposed Actions Scenario (Typical Sale): The number of platforms projected for a WPA and CPA proposed action is 15-23 and 35-67, respectively (**Table 3-2 and 3-3**). The number of rigs-to-reefs anticipated as a result of the WPA and CPA proposed actions is approximately 10 percent of the projected removals, or 1-2 in the WPA and 3-7 in the CPA.

OCS Program Scenario: For the OCS Program from the years 2012-2051, a total of 1,279-1,837 platforms in OCS waters are projected to be removed during the 40-year cumulative activities scenario (**Table 3-4**). If approximately 10 percent of these structures are accepted into the Rigs-to-Reefs Program, there may be as many as 121-118 additional artificial reefs installed in the WPA, CPA, and EPA. Note that offshore and onshore impact-producing factors and scenarios associated with an EPA proposed action (i.e., a typical sale that would result from the proposed lease sales within the EPA, as well as OCS Program activity resulting from past and future leases sales in the EPA) will be disclosed in a subsequent EIS.

3.3.3.6. Offshore Liquefied Natural Gas Projects and Deepwater Ports

One LNG terminal is presently operating on the OCS in the GOM: the Gulf Gateway Energy Bridge. Brought into service in March 2005, the Gulf Gateway Energy Bridge is located in 280 ft (85.3 m) of water in West Cameron, South Addition Block 603, approximately 116 mi (187 km) offshore the Texas-Louisiana border. The Gulf Gateway Energy Bridge is capable of delivering natural gas at a baseload rate of 500 Bcf per day. The license for the Gulf Gateway Energy Bridge operation was issued by DOT's Maritime Administration (MARAD) on May 24, 2004.

Exxon-Mobile's Golden Pass LNG terminal on the Sabine Pass waterway in Jefferson County near the Texas-Louisiana border and Port Arthur, Texas, was scheduled to open in 2009, but it was severely damaged by Hurricane Ike in September 2008. At full operation, Golden Pass will be able to deliver the equivalent of 2 Bcf per day of natural gas. Golden Pass received its first shipment of super-cooled LNG on October 28, 2010, at which time (Gonzalez, 2010) reported that it arrived in the midst of a domestic gas surplus.

"Shale gas" is a new source of onshore natural gas that is easy to reach, and it is throwing plans for LNG terminals into turmoil. Recent technological improvement in hydraulic fracturing tight geologic formations has opened the shale gas frontier. Shale gas is held in fine-grain formations, such as shale, that is difficult to produce without introducing artificial fractures (fracking) through which gas can flow to a wellbore and be produced. The prospect of a larger, more accessible, domestic gas supply acts to depress gas prices and affects the economics for heavily capitalized LNG installations. The Henry Hub price of natural gas between 2002 and 2007 fluctuated between $5.00 and $8.00 Mcf. The price spiked to $15.00 Mcf after the 2005 GOM hurricanes, and a speculative bubble peak high price of $13.00 Mcf was reached in July 2008. With aggressive discovery and production of shale gas and the recent downturn in economic conditions, the Henry Hub price of natural gas in 2009 and 2010 collapsed to fluctuate between $2.00 and $5.00 Mcf for most of this period. The LNG or deepwater port facilities below are now in some stage of the permitting process (USDOT, MARAD, 2010).

Louisiana

Main Pass Energy Hub. Freeport McMoRan filed a notice of revised application on June 22, 2006, to convert a sulphur/brine mining facility into an LNG terminal for regasification. An EIS was prepared and the Governor of Louisiana issued an approval letter on November 20, 2007. The Main Pass Energy Hub would be located 16 mi (26 km) offshore Louisiana in Main Pass Block 299.

Texas

Texas Offshore Port System. On December 8, 2008, the Texas Offshore Port System project filed an application with MARAD seeking approval to build, own, and operate a deepwater port facility for crude oil 30 mi (48 km) southeast of Freeport, Texas, in the GOM. If approved and constructed as planned, the deepwater port should be capable of importing 1.7 million bbl of oil/day into the U.S. and should also facilitate delivery of the waterborne crude to refining centers along the Texas Gulf Coast.

On January 5, 2009, the application was deemed complete, and on January 9, 2009, a Notice of Application was published in the *Federal Register*. Public scoping meetings were held in mid-February 2009 and the comments received were evaluated by MARAD and USCG. On March 13, 2009, MARAD and USCG issued a letter to the Texas Offshore Port System that suspended application processing because of the need for additional environmental and financial data. The applicant is currently in the process of gathering the required information and addressing the identified data gaps. On April 21, 2009, two of the three companies composing the Texas Offshore Port System partnership formally announced their dissociation, or exit, from the proposed project. However, the remaining company has agreed to continue the Texas Offshore Port System project. The MARAD is reviewing information sent by the applicant in order to resolve the data gaps necessary to process the application.

Cumulative Activities Scenario: The economic viability and enthusiasm for LNG facilities over the cumulative activities scenario is expected to decrease over at least the next decade, and perhaps stabilize after that. It is possible that LNG facilities in the GOM or elsewhere now in the permitting process or construction phases could be withdrawn from consideration, cancelled, or deferred until LNG economics improve or until facilities under construction for importing LNG could be modified for exporting LNG.

The BOEM anticipates that, over the next 40 years, two additional LNG facilities in the CPA and a deepwater port in the WPA would be licensed and operating in the cumulative impacts area. Short summaries for the following pending applications for facilities in the cumulative impact area can be found at the MARAD website (USDOT, MARAD, 2010).

3.3.3.7. Development of Gas Hydrates

The DOE and cooperating agencies are in the middle of a multiyear characterization program of naturally occurring methane hydrates (gas hydrates) in the GOM. The first cruise for characterizing GOM gas hydrates took place in 2005, and the second took place in 2009. A third cruise is in the planning stages. Gas hydrates are a unique, energy-rich, and poorly understood class of chemical substances in which molecules of one material (in this case solid-state water ─ 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 (Berecz and Balla-Achs, 1983; Henriet and Mienert, 1998; Collett, 2002). Studying gas hydrates poses unique technical challenges because they occur only in remote and mechanically challenging environments ─ arctic landmasses and deepwater continental shelves. Moreover, they are only stable in high-pressure and low-temperature environments, and they are difficult to extract from their natural setting for laboratory study.

The Methane Hydrate Research and Development Act of 2000 (P.L. 106-193; May 2, 2000) promoted the research, identification, assessment, exploration, and development of methane hydrate resources in the United States as the work of a joint effort between seven Federal agencies. The DOE is the coordinating agency and participants include the USGS, this Agency, BLM, the Naval Research Laboratory, NOAA, and the National Science Foundation. The Methane Hydrate Research and Development Act of 2000 was reauthorized for 2005-2010 in Section 968 of EPAct.

The Methane Hydrate Research and Development Act of 2000 allows DOE to enter into awards, contracts, and cooperative agreements with institutions of higher education or industrial enterprises for the purposes of (1) conducting basic and applied research to identify, explore, assess, and develop methane hydrate as a source of energy; (2) developing technologies required for efficient and environmentally sound development of methane hydrate resources; (3) undertaking research programs to provide safe means of transport and storage of methane produced from gas hydrates; (4) promoting education and training in methane hydrate resource research and resource development; (5) conducting basic and applied research to assess and mitigate the environmental impacts of hydrate degassing (including both natural degassing and degassing associated with commercial development); (6) developing technologies to reduce the risks of drilling through naturally occurring methane hydrates; and (7) drilling in support of authorized activities.

Seismic evidence for gas hydrates typically consists of a bottom simulating reflector at relatively shallow depths below mudline; shallow at least in comparison with conventional oil and gas exploration wells. The bottom simulating reflector is caused by the large acoustic impedance contrast at the base of the gas hydrate stability zone that separates sediments containing gas hydrate above with sediments containing free gas below.

In the Gulf of Mexico, a Joint Industry Project (JIP) was formed to carry out an assessment of gas hydrates. Members of the 2009 JIP included ChevronTexaco (operator); this Agency; ConocoPhillips; Halliburton; Total; Schlumberger; Reliance Industries Limited; Japanese Oil, Gas, and Metals National Corporation; Korea National Oil Company; and StatoilHydro. Three legs to the total JIP were planned. For the first leg in 2005, JIP carried out a test drilling program to sample gas hydrates on the Gulf of Mexico OCS at eight locations in three blocks (Atwater Valley Blocks 13 and 14, and Keathley Canyon Block 151) in the CPA where hydrates were thought to occur. The results of the 2005 JIP were published in the DOE newsletter *Fire in the Ice* (Birchwood et al., 2008).

For the second leg in 2009, JIP was permitted by this Agency to carry out a test drilling program to sample gas hydrates on the Gulf of Mexico OCS at multiple locations in two blocks; Green Canyon Block 955 and Walker Ridge Block 313 in the CPA and Alaminos Canyon Blocks 775, 818, and 819 in the WPA. The JIP modified the WPA drilling program to include two boreholes in Alaminos Canyon Block 21 instead of the originally permitted blocks (Fire in the Ice, 2009) and deployed for Leg II in April 2009 using a dynamically positioned drillship. The test wells were 8.5-in (26.6-cm) in diameter that penetrated shallow sediment up to 3,680 ft (1,122 m) below mudline to allow geophysical logging followed by abandonment procedures. All wells were geophysically logged while drilling with resistivity, borehole imaging, gamma ray, density, neutron porosity, and magnetic resonance logs. Unlike the 2005 JIP program in the GOM, the 2009 JIP did not retrieve pressurized cores of gas hydrate from the sampled holes. Technical reports resulting from the 2009 JIP include Boswell et al. (2009), Kou (2010), and Zhang and McConnell (2011).

This Agency released the results of a systematic geological and statistical assessment of gas hydrates resources in the GOM (USDOI, MMS, 2008a). This assessment incorporates the latest science with regard to the geological and geochemical controls on gas hydrate occurrence. It indicated that a mean volume of 607 trillion m^3 (21,444 Tcf) of methane was in-place in hydrate form. The assessment has determined that a mean of 190 trillion m^3 (6,710 Tcf) of this resource occurs as relatively high-concentration accumulations within sand reservoirs that may some day be produced. The remainder occurs within clay-dominated sediments from which methane probably would never be economically or technically recoverable.

Cumulative Activities Scenario: The BOEM anticipates that, over the next 40 years, JIP will complete the third leg of their characterization project for GOM gas hydrates in the cumulative impacts area. Within 40 years, it is likely that the first U.S. domestic production from hydrates may occur in Alaska, where gas obtained from onshore hydrates will either support local oil and gas field operations or be available for commercial sale if and when a gas pipeline is constructed to the lower 48 states. However, Moridis et al. (2008, p. 4) stated that it is not possible to discount the possibility that first U.S. domestic production of gas hydrates could occur in the GOM. Despite the substantially increased complexity and cost of offshore operations, there is a mature network of available pipeline capacity and easier access to markets in the GOM.

3.3.3.8. Renewable Energy and Alternative Use

On August 8, 2005, President George W. Bush signed the Energy Policy Act (EPAct) into law. Section 388 (a) of EPAct amended Section 8 of the OCSLA (43 U.S.C. 1337) to authorize DOI to grant leases, easements, or rights-of-way on the OCS for the development and support of energy resources other than oil and gas and to allow for alternate uses of existing structures on OCS lands.

A final programmatic EIS for the OCS renewable energy program was published by this Agency in October 2007 (USDOI, MMS, 2007e) and a Record of Decision was published in the *Federal Register* on January 10, 2008 (*Federal Register*, 2008a). The Act authorized this Agency to develop a comprehensive program and regulations to implement the new authority. Final rules for the renewable energy program were published on April 29, 2009, as 30 CFR 285 (*Federal Register*, 2009b).

The two primary categories of renewable energy that have potential for development in the coastal and OCS waters of the U.S. are (1) wind turbines and (2) marine hydrokinetic systems. The first and most technologically mature renewable energy is wind energy, a popular source of clean and renewable energy that has been in use for centuries. At present, 45 offshore wind farms are in operation off the coasts of the United Kingdom and mainland Europe in waters generally shallower than 30 m (100 ft), and 10 more offshore wind farms are currently under construction there (European Wind Energy Association, 2011). China and Japan also have offshore wind farms and plan to expand their offshore wind power (Feldman, 2009; Schwartz, 2010; Singh, 2010; offshoreWIND.biz, 2010).

Ocean wind energy has emerged as a promising renewable energy resource for a number of reasons: (1) the strength and consistency of winds on the ocean are roughly proportional to distance from shore, the farther from shore the stronger and more persistent; (2) offshore wind generating facilities (wind parks) can therefore be located in proximity to major load centers in the energy-constrained northeastern U.S.; (3) long-term potential for the over-the-horizon siting and undersea transmission lines counters the aesthetics and land-use concerns associated with onshore wind installations and those that can be seen easily from shore; and (4) as a fuel, wind is both cost-free and emission free (Massachusetts Technology Collaborative, 2005).

The DOE released a predecisional strategic plan for creating an offshore wind industry in the U.S. (USDOE, 2010). In this plan, DOE determined that offshore wind energy can help the Nation reduce its greenhouse gas emissions, diversify its energy supply, provide cost-competitive electricity to key coastal regions, and stimulate economic revitalization of key sectors of the economy. However, if the Nation is to realize these benefits, key barriers to the development and deployment of offshore wind technology must be overcome, including the relatively high cost of energy, technical challenges surrounding installation and grid interconnection, and the untested permitting processes governing deployment in both Federal and State waters. There are two critical objectives to realize the strategic plan's goals: (1) reduce the cost of offshore wind energy; and (2) reduce the timeline for deploying offshore wind energy (USDOE, 2010, p. 1). Since April 29, 2009, when the regulations governing renewable energy on the OCS were promulgated, no wind park developments have been proposed in OCS waters of the GOM; however, there have been proposals in Texas coastal waters.

The second category of offshore renewable energy is marine hydrokinetic systems, which are in a more developmental stage relative to wind turbines. The marine hydrokinetic systems consist of devices capable of capturing energy from ocean waves and currents. There has been no interest expressed in wave or current technologies in the GOM because the conditions necessary for their deployment are not suitable to the Gulf. The marine hydrokinetic current technologies are actively being considered for the east coast of Florida where the Gulf Stream provides a strong and continuous source of energy to turn underwater turbines.

The EPAct clarifies the Secretary's authority to allow the existing oil and gas structures on OCS lands to remain in place after production activities have ceased and to transfer liability and extend the life of these facilities for non-oil and gas purposes, such as research, renewable energy production, aquaculture, etc., before being removed. With approximately 1,900 bottom-founded platform structures located in OCS waters, the GOM would seem to have some potential for the reuse of these facilities. Although BOEM has had conversations with developers about conceptual ideas for alternative use projects, no developer has stepped forward with an application to actualize one.

Cumulative Activities Scenario: The BOEM anticipates that, over the next 40 years, at least one alternative use project would be brought to BOEM for action in the area off Texas. It is also likely that at least one wind park project, in addition to the known projects in Texas waters, will be proposed offshore Louisiana in the cumulative impact area. A project could consist of a combination of integrated existing GOM infrastructure with new-built facilities. Such a projection is made because this type of project was vetted to this Agency in 2004, before EPAct was passed to set up the framework to permit and regulate renewable energy projects on the OCS.

Renewable Energy Projects in Texas State Waters

On October 24, 2005, the Texas General Land Office announced authorization for the first offshore wind energy project in the United States to be built in State waters off the Texas coast. An 11,355-ac (4,595-ha) lease was awarded to Galveston-Offshore Wind, L.L.C., a subsidiary of Louisiana-based Wind Energy Systems Technologies. The lease allows work to begin immediately on the construction of two meteorological towers to gather wind resource data to determine exactly where 50 wind turbines would be placed for the 150-megawatt development. The lease area is located approximately 7 mi (11 km) southeast of Galveston Island in Texas Blocks 187 and 188. State waters in Texas, unlike the other states, extends 3 leagues (10.3 mi; 16.5 km) offshore, an artifact of Texas having been admitted to the Union as an independent country in 1845. In October 2007, the Texas General Land Office held a competitive auction for four additional offshore wind lease sites in State waters. Wind Energy Systems Technologies won the competition and was awarded the rights for these additional leases south of the Galveston-Offshore Wind, L.L.C. project area and, which would be developed after the Galveston project.

Wind Energy Systems Technologies has agreed to a three-phase lease agreement for development of the Galveston lease area. During phase 1, Wind Energy Systems Technologies will spend $3-$5 million to build and operate two, 80-m-tall (262-ft) meteorological towers designed to collect wind data in the GOM. Wind Energy Systems Technologies will also pay the State a lease rent of $10,000 a year until actual wind energy production begins. Concurrently, studies of bird migration patterns will be done and information required for State and Federal permits will be gathered.

Once the characterization Phase 1 is complete, Phase 2 involves construction that is expected to cost as much as $300 million and could take as long as 5 years. Phase 3 is a 30-year operating period over which time the developer would pay into the Texas Permanent School Fund through the Texas General Land Office at graduated rates over time.

3.3.4. Other Major Factors Influencing Coastal Environments

Natural and man-caused factors influence the coastal areas of the Gulf States while OCS activity takes place at the same time. Some of these factors are (1) sea-level rise and subsidence; (2) Mississippi Delta hydromodifications; (3) maintenance dredging activities; (4) Coastal Impact Assistance Program activities; and (5) coastal restoration programs.

3.3.4.1. Sea-Level Rise and Subsidence

The Delta Plain and Chenier Plain of the LCA are experiencing relatively high subsidence rates as part of the Mississippi River's delta system. All coastlines of the world have been experiencing a gradual absolute rise of sea level that is based on measurements across the globe and that extends across the influence of a single sedimentary basin. There are two aspects of sea-level rise during the most geologically recent 10,000 years (Holocene Epoch): absolute rise and relative rise. Absolute sea-level rise refers to a net increase in the volume of water in the world's oceans. Relative sea-level rise refers to the appearance of sea-level rise, a circumstance where subsidence of the land is taking place at the same time that an absolute sea-level change may be occurring. Geologists tend to consider all sea-level rise as relative because the influence of one or the other is difficult to separate over geologic time frames.

An absolute sea-level rise would be caused by the following two main contributors to the volume of ocean water on the Earth's surface: (1) change in the volume of ocean water based on temperature; and (2) change in the amount of ice locked in glaciers, mountain ice caps, and the polar ice sheets. For the period 1961-2003, thermal expansion of the oceans accounts for only 23 ± 9 percent of the observed rate of sea-level rise (Intergovernmental Panel on Climate Change, 2007a, Chapter 5 and Table 5.3), the remainder is water added to the oceans by melting glaciers, ice caps, and the polar ice sheets. The contribution of thermal expansion is between 14 and 32 percent of the total absolute sea level rise over this 42-year period. The remainder, approximately 75 percent, of sea-level rise is attributed to melt water.

Measurement of sea-level rise over the last century is based on tidal gauges and, more recently, satellite observations, that are not model-dependent. Projections for future sea-level rise are dependent on temperature. As determined by analysis of air bubbles trapped in Antarctic ice cores, today's atmospheric concentration of CO_2 is the highest it has ever been over the last 800,000 years (Karl et al., 2009, p. 13). Although the measured data for atmospheric CO_2 concentration or temperatures measurements since the Industrial Revolution are generally not in dispute, proxy data for climates of the geologic past are a source of debate and the models constructed to make projections for how climate may change remain controversial. Climate models are very sophisticated, but they may not account for all variables that are important or may not assign to modeled variables the weight of their true influence.

The Intergovernmental Panel on Climate Change reported that, since 1961, global average sea level (mean sea level) has risen at an average rate of 1.8 millimeter/year (mm/yr) (0.07 in/yr) and, since 1993, at 3.1 mm/yr (0.12 in/yr) (Intergovernmental Panel on Climate Change, 2007a). Whether the faster rate for 1993-2003 reflects decadal variability or an increase in the longer-term trend is unclear. In the structured context used by the Intergovernmental Panel on Climate Change, there is high confidence that the observed sea-level rise rate increased from the 19^{th} to the 20^{th} century. The average global rate for the 20^{th} century was determined by Bindoff et al. (2007, Section 5.5.2.1) to be 1.7 ± 0.5 mm/yr and the total 20^{th}-century average rise is estimated to be 0.17 m (0.55 ft) (Intergovernmental Panel on Climate Change, 2007a). The U.S. Global Change Research Program reported that over the last 50 years sea-level has risen up to 8 in (203 mm) along parts of the Atlantic and Gulf Coasts that included Louisiana and Texas (Karl et al., 2009, p. 37), and that global sea level is currently rising at an increasing rate.

Although absolute sea-level rise is a contributor to the total amount of sea-level rise along the Gulf Coast, subsidence is the most important contributor to the total. In comparison to other areas along the Gulf Coast, Louisiana's Mississippi Delta and Chenier Plains are built of young sediments deposited over the last 7,000 years. These deltaic sediments have been undergoing compaction and subsidence since they were deposited. The land is sinking at the same time that sea level is rising, contributing to high rates of relative sea-level rise along the Louisiana coast. Blum and Roberts (2009) posited three scenarios for subsidence and sea-level rise, and they concluded sediment starvation alone would cause ~2,286 mi^2 (592,071 ha) of the modern delta plain to submerge by 2050, without any other impacting factors contributing to landloss.

A general value of ~6 mm/yr (0.23 in) of subsidence from sediment compaction, dewatering and oxidation of organic matter (Meckel et al., 2006; Dokka, 2006) is a reasonable rate to attribute to the Louisiana coastal area, with the understanding that subsidence rates along the Louisiana coast are spatially variable and influenced by subsurface structure and the timing and manner that the delta was deposited. Applied to the entire coast, it is an oversimplification of a complex system, but it is an estimate that is reasonable based on recent data.

Stephens (2009 and 2010a) reported that the influence of subsurface structure has not been taken into account in subsidence assessments in the LCA and along the Gulf Coast (Stephens, 2009, p. 747). Most workers studying the affects of subsidence along the LCA have focused on surficial or near-surface geologic data sources and have made no attempt to integrate basin analysis into planning for coastal restoration or flood control project planning.

The BOEM anticipates that, over the next 40 years, the LCA will likely experience a total of relative sea-level rise of ~45 cm (18 in), or approximately 9 mm/yr (0.35 in). This estimate is made by combining the estimated rate for subsidence (~6 mm/yr) (0.23 in) and the estimated rate for absolute sea-level rise (~3 mm/yr) (0.12 in).

Formation Extraction and Subsidence

Extracting fluids and gas from geologic formations can lead to localized subsidence at the surface. The Texas Gulf of Mexico coast is experiencing high (5-11 mm/yr) (0.19-0,43 in) rates of relative sea-level rise that are the sum of subsidence and eustatic sea-level rise (Sharp and Hill, 1995) Even higher rates are associated with areas of groundwater pumping from confined aquifers. Berman (2005, Figure 3) reported that 2 m (6 ft) of subsidence has occurred in the vicinity of the Houston Ship Channel by the mid-1970s as a result of groundwater withdrawal.

Morton et al. (2005) examined localized areas or “hot spots” corresponding to fields in the LCA where oil, gas, and brine were extracted at known rates. Morton et al. (2005, Figure 26) shows measured subsidence along transects across these fields that range from 18 to 4 mm/yr (0.7 to 0.15 in), with the greatest rates tending to coincide with the surface footprints of oil or gas fields. Mallman and Zoback (2007) interpreted downhole pressure data in several Louisiana oil fields in Terrebonne Parish and found localized subsidence over the fields; however, they could not link these localized rates to the subsidence measured and observed on a regional scale.

Down-to-the-basin faulting, also called listric or growth faulting, is a long recognized fault style along deltaic coastlines, and the Mississippi Delta is no exception (Dokka et al., 2006; Gagliano, 2005a). There is currently disagreement in the literature regarding the primary cause of modern fault movement in the Mississippi Delta region, and the degree to which it is driven by fluid withdrawal or sediment compaction resulting from the sedimentary pile pressing down on soft, unconsolidated sediments that causes downward and toward the basin movement along surfaces of detachment in the shallow and deep subsurface.

Berman (2005) discussed the conclusions of Morton et al. (2005) and believed that they failed to make the case that hydrocarbon extraction caused substantial subsidence over the broader area of coastal Louisiana, a conclusion also reached by Gagliano (2005b).

Cumulative Activities Scenario: Oil production on the LCA peaked at 513 million bbl in 1970 and gas production peaked at 7.8 MMcf in 1969 (Ko and Day, 2004a). From the peak, the level of production activity is slowly decreasing. The magnitude of subsidence caused by formation extraction is a function of how pervasive the activity is across the LCA. The oil and gas field maps in Turner and Cahoon (1987, Figure 4) and Ko and Day (2004a, Figure 1) seem an adequate basis to estimate the LCA’s oil- and gas-field footprint at ~20 percent of the land area. The amount of subsidence from formation extraction is also occurring on a delta platform that is experiencing natural subsidence and sea-level rise. Fluid and gas extraction may lead to high local subsidence on the scale of individual oil and gas fields, but not as a pervasive contributor to regional subsidence across the LCA.

3.3.4.2. Mississippi River Hydromodification

The Mississippi River has been anchored in place by engineered structures built in the 20th century and has been hydrologically isolated from the delta it built. The natural processes that allowed the river to flood and distribute alluvial sediments across the delta platform and channels to meander have been shut down. Hydromodifying interventions include construction of (1) levees along the river and distributary channel systems, (2) upstream dams and flood control structures that impound sediment and meter the river flow rate, and (3) channelized channels with earthen or armored banks. Once the natural processes that act to add sediment to the delta platform to keep it emergent are shut down, subsidence begins to outpace deposition of sediment.

Of total upstream-to-downstream flow, the Old River Control Structure (built 1963) diverts 70 percent of flow down the levee-confined channels of the Mississippi River and 30 percent down the unconfined Atchafalaya River, which has been actively aggrading its delta plain since 1973 (LaCoast.gov, 2011). Blum and Roberts reported that the time-averaged sediment load carried by the Mississippi and Atchafalaya Rivers before installation of the Old River Control Structure was ~400-500 million tons per year and that the average suspended load available to either river after construction of the Old River Control Structure was ~205 million tons per year (Blum and Roberts, 2009, Figure 2). Modern sediment loads are, therefore, less than half that required to build and maintain the modern delta plain, a figure largely in agreement with previous work reporting decreases in suspended sediment load of nearly 60 percent since the 1950's (Turner and Cahoon, 1987, Figure 3-8; Tuttle and Combe, 1981).

Blum and Roberts (2009, Figure 3b) posited three scenarios for subsidence and sea-level rise, and concluded sediment starvation alone would cause ~2,286 mi^2 (592,071 ha) of the modern delta plain to submerge by 2050 without any other impacting factors contributing to landloss. The use of sediment budget modeling, a relatively new tool for landloss assessment, appears to indicate that hydrographic modification of the Mississippi River has been the most profound man-caused influence on landloss in the LCA. Sediment starvation of the deltaic system is allowing rising sea level and subsidence to outpace the constructive processes building and maintaining the delta.

Cumulative Activities Scenario: The BOEM anticipates that, over the next 40 years, there might be minor sediment additions resulting from new and continuing freshwater diversion projects managed by COE. Of the 179 projects in the CWPPRA program (LaCoast.gov, 2010a), 27 involve introduction of sediment or reestablishment of natural water and sediment flow regimes to allow the delta plain to replenish and build up; 10 are freshwater diversion projects, 5 are outfall management, 1 is sediment diversion, and 16 are marsh creations. Insofar as these projects represent land additions to the LCA, they are already accounted for in the discussion below under coastal restoration programs.

3.3.4.3. Maintenance Dredging and Federal Channels

Along the Texas Gulf Coast there are eight Federally-maintained navigation channels in addition to the GIWW. Most of the dredged materials from the Texas channels have high concentrations of silt and clay. Beneficial uses of dredged material include beach nourishment for the more sandy materials, and storm reduction projects or ocean disposal for much of the finer-gained material. Ocean disposal locations along the Texas coast are situated so that materials are placed on the down drift side of the channel (U.S. Dept. of the Army, COE, 1992, p. 56).

Maintenance dredging activity from 2000 through 2008 for Federal channels by the Galveston District of the Corps of Engineers are reported in COE's Ocean Disposal Database (U.S. Dept. of the Army, COE, 2011b) (**Table 3-33**). **Table 3-33** shows the quantity of dredged material disposed of in ocean dredged material disposal sites only. **Table 3-34** shows the same information for Federal channels in Louisiana, and **Table 3-35** shows the same information for Federal channels in Mississippi, Alabama, and Florida.

There are 10 Federal navigation channels in the LCA, ranging in depth from 4 to 14 m (12 to 45 ft) and in width from 38 to 300 m (125 to 1,000 ft) that were constructed as public works projects beginning in the 1800's (Good et al., 1995, Table 1). The combined length of the Federal channels in Good et al. was reported as 2,575 mi (1,600 km) with three canals considered deep-draft and seven as shallow (Good et al., 1995, p. 9). The 2007-2012 Multisale EIS (USDOI, MMS, 2007d, p. 4-316) reported 1,243 mi (2,000 km) of OCS-related navigation channels. The Federal navigation channels in Louisiana identified by Good et al. (1995, Table 1) are as follows: (1) GIWW East of Mississippi River; (2) Mississippi River Gulf Outlet; (3) GIWW between the Atchafalaya and Mississippi Rivers; (4) GIWW West of Atchafalaya River; (5) Barataria Bay Waterway; (6) Bayou Lafourche; (7) Houma Navigation Canal; (8) Mermentau Navigation Channel; (9) Freshwater Bayou; and (10) Calcasieu River Ship Channel.

Turner and Cahoon (1987, Table 4-1) and DOI (USDOI, MMS, 2007d, Table 3-36) identified OCS-related channels that bore traffic supporting the OCS Program. Between these works and Good et al. (1995, Table 1) channel names do not well agree and a comparison is difficult. No channel is exclusively used by OCS Program traffic and only a fraction of total traffic is attributable to OCS use; approximately 12 percent (USDOI, MMS, 2007d, p. 4-316). The BOEM staff compiled **Table 3-36** using the information in industry plans to show that, between 2003 and 2008, the vast majority (80-90%) of OCS service vessels used service-base facilities in the LCA that are located along rivers or that lie within wetlands that are already saline or brackish. **Table 3-36** shows that the contribution of OCS Program traffic to bank degradation and freshwater wetland loss is minimal.

The GIWW is a Federal, shallow-draft navigation channel constructed to provide a domestic connection between Gulf ports after the discovery of oil in East Texas in the early 1900's, as well as the growing need for interstate transport of steel and other manufacturing materials. It extends approximately 1,400 mi (2,253 km) along the Gulf Coast from St. Marks in northwestern Florida to Brownsville, Texas, with the Louisiana part reported to be 994 mi (1,600 km) in length (Good et al., 1995, p. 9). With the exception of the east-west GIWW in Louisiana, Federal channels are sub-perpendicular with the GOM shoreline or saltwater bays, making them vulnerable to saltwater intrusion during storms.

Direct cumulative impacts include the displacement of wetlands by original channel excavation and disposal of the dredged material. Good et al. (1995, Table 1) estimated that direct impacts from the construction of Federal navigation channels were between 58,000 and 96,000 ac (23,472 and 38,850 ha). Indirect cumulative landlosses resulted from hydrologic modifications, saltwater intrusion, or bank erosion from vessel wakes (Wang, 1988). Once cut, navigation canals tend to widen as banks erode and subside, depending on the amount of traffic using the channel. Good et al. (1995, Table 1) estimated indirect impacts on wetland loss from bank erosion at 35,000 ac (14,164 ha).

The COE reported that the New Orleans District has the largest channel maintenance dredging program in the U.S., with an annual average of 70 million yd^3 of material dredged (U.S. Dept. of the Army, COE, 2009a, p. 26). Of that total, COE's Ocean Disposal Database indicates that about 16 million yd^3 were disposed at ODMDS sites by the New Orleans District (U.S. Dept. of the Army, COE, 2011a) (**Chapter 3.3.3**). Federal channels and canals are maintained throughout the onshore cumulative impact area by COE, State, county, commercial, and private interests. Proposals for new and maintenance dredging projects are reviewed by Federal, State, and local agencies as well as by private and commercial interests to identify and mitigate adverse impacts upon social, economic, and environmental resources.

Maintenance dredging is performed on an as-needed basis. Typically, COE schedules surveys every 2 years on each navigation channel under its responsibility to determine the need for maintenance dredging. Dredging cycles may be from 1 to as many as 11 years from channel to channel and from channel segment to channel segment. The COE is charged with maintaining all larger navigation channels in the cumulative activities area. The COE dredges millions of cubic meters of material per year in the cumulative activities area, most of which is under the responsibility of the New Orleans District. Some shallower port-access channels may be deepened over the next 10 years to accommodate deeper draft vessels. Vessels that support deepwater OCS activities may include those with drafts to about 7 m (23 ft).

Construction and maintenance dredging of rivers, navigation channels, and pipeline access canals can furnish sediment for beneficial purpose, a practice the COE calls beneficial use of dredge materials program. Drilling, production activity, and maintenance at most coastal well sites in Louisiana require service access canals that undergo some degree of aperiodic maintenance dredging to maintain channel depth, although oil and gas production on State lands peaked in 1969-1970 (Ko and Day, 2004a, p. 398). In recent years, dredged materials have been sidecast to form new wetlands using the beneficial use of dredge materials program. Potential areas suited for beneficial use of dredged material are considered most feasible within a 10-mi (16-km) boundary around authorized navigation channels in the New Orleans District, but the potential for future long distance pipelines for disposal of dredged material could increase the potential area available for the beneficial use of dredge materials program considerably (U.S. Dept. of the Army, COE, 2009a, p. 27).

Current figures vary for how much of the average annual 70 million yd^3 (53,518,840 m^3) that is dredged by the New Orleans District is available for the beneficial use of dredge materials program: from 15 million yd^3 (11,468,320 m^3) (U.S. Dept. of the Army, COE, 2009a, p. 26) to 30 million yd^3

(22,936,650 m^3) (Green, 2006, p. 6), or between 21 and 43 percent of the total. The COE reported that, over the last 20 years, approximately 10,117 ha (25,000 ac) of wetlands have been created with dredged materials, most of which are located on the LCA delta plain (U.S. Dept. of the Army, COE, 2009b, p. 8).

Cumulative Activities Scenario: The construction of Federal channels is not a growth industry that would lead to future direct taking of wetlands, and at least one Federal channel in Louisiana (Mississippi River Gulf Outlet) has been decommissioned and sealed with a rock barrier as of July 2009 (Shaffer et al., 2009, p. 218). The DOI has used a widening rate for OCS-related channels of 1.5 m/yr (4.9 ft/yr) (USDOI, MMS, 2007d, p. 4-316). Using DOI's estimate of 2,000,000 m (1,243 mi) of OCS-related channel length (USDOI, MMS, 2007d, p. 4-316) and the estimated bank widening rate of 1.5 m/yr (5 ft/yr) for OCS-related channels, an annual landloss of ~741 ac/yr (300 ha/yr) may be estimated. Therefore, during the 40-year cumulative activities scenario, landloss from indirect impacts on Federal navigation channels could be ~29,653 ac (12,000 ha). The use of Federal channels by OCS-related traffic is ~12 percent of total capacity, and an estimate may be made for the OCS Program's contribution to bank erosion over the 40 year cumulative scenario of 3,558 ha (8,791 ac).

If the pattern over the next 20 years for the amount of wetland created through the beneficial use of dredge material remains about the same as the amount of land created over the past 20 years, approximately 10,117 ha (25,000 ac) (U.S. Dept. of the Army, COE, 2009b, p 8), BOEM anticipates that approximately 20,234 ha (50,000 ac) of wetland area may be created or protected in the LCA. Subtracting projected land lost by bank degradation and channel widening, approximately 29,653 ac (12,000 ha) from land added by the beneficial use of dredge material, an estimated land addition of approximately 8,234 ha (20,346 ac) could be expected over the next 40 years.

3.3.4.4. Coastal Restoration Programs

The Mississippi Delta sits atop a pile of Mesozoic and Tertiary-aged sediments up to 7.5 mi (12.2 km) thick at the coast and it may be as much as 60,000 ft (18,288 m) or 11.4 mi (18.3 km) thick offshore (Gagliano, 1999). Five major lobes are generally recognized within about the uppermost 50 m (164 ft) of sediments (Britsch and Dunbar, 1993; Frazier, 1967, Figure 1). The oldest lobe contains peat deposits dated as 7,240 years old (Frazier, 1967, p. 296). The youngest delta lobe of the Mississippi Delta is the Plaquemines-Balize lobe that has been active since the St. Bernard lobe was abandoned about 1,000 years ago. The lower Mississippi River has shifted its course to the GOM every thousand years or so, seeking the most direct path to the sea while building a new deltaic lobe. Older lobes were abandoned to erosion and subsidence as the sediment supply was shut off. Because of the dynamics of delta building and abandonment, the Louisiana coastal area (U.S. Dept. of the Army, COE, 2004a) experiences relatively high rates of subsidence relative to more stable coastal areas eastward and westward.

The first systematic program authorized for coastal restoration in the LCA was the 1990 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), otherwise known as the "Breaux Act." Individual CWPPRA projects are designed to protect and restore between 10 and 10,000 ac (4 and 4,047 ha), require an average of 5 years to transition from approval to construction, and are funded to operate for 20 years (U.S. Government Accountability Office, 2007, p. 2), a typical expectation for project effectiveness (Campbell et al., 2005, p. 245).

The 1990 CWPPRA introduced an ongoing program of relatively small projects to partially restore the coastal ecosystem. As the magnitude of Louisiana's coastal landlosses and ecosystem degradation became more apparent, so too appeared the need for a more systematic approach to integrate smaller projects with larger projects to restore natural geomorphic structures and processes. The Coast 2050 report (LDNR, 1998) combined previous restoration planning efforts with new initiatives from private citizens, local governments, State and Federal agency personnel, and the scientific community to converge on a shared vision to sustain the coastal ecosystem. The LCA Ecosystem Restoration Study (U.S. Dept. of the Army, COE, 2004a) built upon the Coast 2050 Report. The LCA's restoration strategies generally fell into one of the following categories: (1) freshwater diversion; (2) marsh management; (3) hydrologic restoration; (4) sediment diversion; (5) vegetative planting; (6) beneficial use of dredge material; (7) barrier island restoration; (8) sediment/nutrient trapping; and (9) shoreline protection, as well as other types of projects (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2006, Table 1).

Following Hurricanes Katrina and Rita in 2005, an earlier emphasis on coastal or ecosystem restoration of the LCA was reordered to at least add an equal emphasis on hurricane flood protection. The Department of Defense Appropriations Act of 2006 authorized COE to develop a comprehensive hurricane protection analysis to present a full range of flood control, coastal restoration, and hurricane protection measures for south Louisiana (U.S. Dept. of the Army, COE, 2009c). The Appropriations Act required Louisiana to create a State organization to sponsor the hurricane protection and restoration projects that resulted. The State legislature established the Coastal Protection and Restoration Authority and charged it with coordinating the efforts of local, State, and Federal agencies to achieve long-term, integrated flood control and wetland restoration. The Coastal Protection and Restoration Authority produced a comprehensive master plan for a sustainable coast (State of Louisiana, 2007) as their vision of an integrated program of what had been separate areas of activity—flood protection and coastal restoration. The Coastal Protection and Restoration Authority's Annual Plans prioritize the types of projects undertaken each fiscal year. It is not entirely clear how coordination between the State and Federal authorities is undertaken in order to develop the range of projects selected for the State's Coastal Protection and Restoration Authority's Annual Plan and COE's plan (U.S. Dept. of the Army, COE, 2009a, Figures 17-1, 17-2, and 17-3).

The U.S. Government Accountability Office (GAO) recently audited the CWPPRA Program (U.S. Government Accountability Office, 2007). The GAO reported 74 completed CWPPRA projects between 1994 and 2007 that resulted in 58,781 "anticipated total acres" (23,788 ha) and 16 projects under construction as of mid-2007 that are reported to result in 20,860 anticipated total acres (8,442 ha) (U.S. Government Accountability Office, 2007, Tables 2 and 3). Of the 74 projects constructed since 1994, more than half were one of two types—shoreline protection or hydrologic restoration. Of the 179 CWPPRA priority projects listed on LaCoast.gov (2010b), 55 projects with 31,187 ac (12,621 ha) "total net acres" (defined as the sum of reestablished and protected acres present at the end of 20 years) are not found on GAO's completed or underway lists (U.S. Government Accountability Office, 2007, Tables 2 and 3), leading to a conclusion that these projects are in line for completion before 2019.

Cumulative Activities Scenario: The BOEM's anticipates that, over the next 40 years, ~12,621 ha (31,187 ac) of land would be added, or 316 ha/yr (781 ac/yr) between now and 2019. This estimate is based in the assumption that the full menu of 179 CWPPRA projects now anticipated (LaCoast.gov, 2010b) are completed by the end of the authorization period in 2019.

There is no simple way to anticipate what projects under the protection of the State's Coastal Protection and Restoration Authority are admitted to its Annual Plan and completed. There is also no simple way to anticipate what projects are undertaken for COE's comprehensive range of flood control, coastal restoration, and hurricane protection measures for the LCA will feed into the Coastal Protection and Restoration Authority's Annual Plan for authorization and which ones will be ultimately completed. Because these projects are chosen on the basis of annual appropriations, there is no simple way to establish projections for land added or preserved over the cumulative activities scenario.

Coastal Impact Assistance Program

The Energy Policy Act of 2005 was signed into law by President Bush on August 8, 2005. Section 384 of EPAct amended Section 31 of the OCSLA (43 U.S.C. 1356(a)) to establish the Coastal Impact Assistance Program (CIAP). The authority and responsibility for the management of CIAP is vested in the Secretary of the Interior; the Secretary delegated this authority and responsibility to this Agency up until September 30, 2011. In 2011, it was announced that FWS would take over administration of CIAP effective October 1, 2011, since the program aligns with the FWS conservation mission and similar grant programs run by FWS. The eligibility requirements for States, coastal political subdivisions, and fundable projects are expected to remain largely the same after the transfer.

The CIAP provides Federal grant funds derived from Federal offshore lease revenues to oil-producing states for conservation, protection, or restoration of coastal areas. This includes wetlands; mitigation of damage to fish, wildlife, or natural resources; planning assistance and the administrative costs of complying with these objectives; implementation of a federally approved marine, coastal, or comprehensive conservation management plan; and mitigation of the impact of OCS activities through the funding of onshore infrastructure projects and public service needs. Under Section 384 of EPAct, the

Secretary of the Interior was directed to disburse $250 million for each of the fiscal years (FY) 2007 through 2010 to eligible OCS oil- and gas-producing States and coastal political subdivisions.

Eligible CIAP States	Eligible CIAP Coastal Political Subdivisions
Alabama	Baldwin and Mobile Counties
Alaska	Municipality of Anchorage and Bristol Bay, Kenai Peninsula, Kodiak Island, Lake and Peninsula, Matanuska-Susitna, North Slope, and Northwest Arctic Boroughs
California	Alameda, Contra Costa, Los Angeles, Marin, Monterey, Napa, Orange, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, and Ventura Counties
Louisiana	Assumption, Calcasieu, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Mary, St. Tammany, Tangipahoa, Terrebonne, and Vermilion Parishes
Mississippi	Hancock, Harrison, and Jackson Counties
Texas	Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Harris, Jackson, Jefferson, Kenedy, Kleberg, Matagorda, Nueces, Orange, Refugio, San Patricio, Victoria, and Willacy Counties

The Gulf Coast Ecosystem Restoration Task Force

The Gulf Coast Ecosystem Restoration Task Force was set up by an Executive Order signed by President Obama on October 5, 2010 (The White House, 2010). The Task Force stated the Federal Government's desire to address long-standing ecological decline and to begin moving toward a more resilient Gulf Coast ecosystem, especially in the aftermath of the DWH event. The Executive Order expressed the Federal Government's commitment to help residents conserve and restore resilient and healthy GOM ecosystems that support and sustain the diverse economies, communities, and cultures of the region, and the important national missions carried out in the GOM.

The specific goals of the Task Force are to support economic vitality, enhance human health and safety, protect infrastructure, enable communities to better withstand impact from storms and climate change, sustain safe seafood and clean water, provide recreational and cultural opportunities, protect and preserve sites that are of historical and cultural significance, and contribute to the overall resilience of coastal communities. To support and enable these goals, the Task Force's role is to coordinate intergovernmental responsibilities, planning, and exchange of information so as to better implement ecosystem restoration and to facilitate appropriate accountability and support throughout the restoration process. The Executive Order directed Federal efforts to be efficiently integrated with those of local stakeholders, and that particular focus should be toward innovative solutions for complex, large-scale restoration projects. The Executive Order seeks science-based and well-coordinated solutions that minimize duplication and ensure effective delivery of services.

3.3.5. Natural Events and Processes

3.3.5.1. Physical Oceanography

Physical oceanographic processes in the GOM that contribute to the distribution of spilled oil include the Loop Current, Loop Current eddies, and whirlpool-like features underneath the Loop Current and Loop Current eddies that interact with the bottom. Infrequently observed processes include a limited number of high-speed current events, at times approaching 100 cm/s (39 in/s). These events were observed at depths exceeding 1,500 m (4,921 ft) in the northern GOM (Hamilton and Lugo-Fernandez, 2001; Hamilton et al., 2003) and as very high-speed currents in the upper portions of the water column observed in deep water by several oil and gas operators. All of these processes are further described in **Appendix A.2**. Generally, current speed in the deep GOM has been observed to decrease with depth. Mean deep flow around the edges of the GOM circulates in a counterclockwise direction, as observed at ~2,000 m (6,562 ft) (Sturges et al., 2004) and at ~900 m (2,953 ft) (Weatherly, 2004).

Mean seasonal circulation patterns of inner-shelf and outer-shelf currents on the Louisiana-Texas continental shelf, the northeastern GOM shelf, and the West Florida shelf are described in **Appendix A.2**.

These currents are primarily wind driven and are also influenced by riverine outflow. Cold water from deeper off-shelf regions moves onto and off the continental shelf by cross-shelf flow associated with upwelling and downwelling processes in some locations (Collard and Lugo-Fernandez, 1999). Wind events such as tropical cyclones (especially hurricanes), extratropical cyclones, and cold-air outbreaks can result in extreme waves and cause currents with speeds of 100-150 cm/s (39-59 in/s) over continental shelves. These extreme events would likely cause oil to be transported further into coastal habitats, such as up onto beaches and into marshes.

Currents at depth in deep waters of the GOM will strongly impact the transport and fate of oil spills in these waters, including the evolution of subsurface plumes. With relevance to this topic, several new reports on circulation of the Gulf's deep waters have recently been completed. The main findings from such studies are as follows: (1) the deep Gulf can be approximated as a two-layer system with an upper layer about 800- to 1,000-m (2,625- to 3,281-ft) thick that is dominated by the Loop Current and associated clockwise whirlpools (Welsh et al., 2009; Inoue et al., 2008); (2) the lower layer below ~1,000 m (3,281 ft) has near uniform currents (Cox et al., in press; Welsh et al., 2009; Inoue et al., 2008); (3) the coupling between these two layers is generally absent, but it seems that motions of the layer interface are needed to transmit the energy from the Loop Current and eddies downward (Cox et al., in press; Welsh et al., 2009; Inoue et al., 2008, Donohue et al., 2008); (4) there is a wealth of secondary whirlpools with smaller diameters (50-100 km; 31-62 mi) that affect the exchange between the shelf and deepwater, and these smaller whirlpools interact with the larger Loop eddies (Donohue et al., 2008); and (5) the ocean's response to tropical storms and hurricanes is similar to that reported previously, but a new mode was found to transport the hurricane's energy downward related to the sea-level rise near the storm eye (Welsh et al., 2009; Cole and DiMarco, 2010).

Caribbean Sea waters colliding with the Yucatan Peninsula turn northward and enter the Yucatan Channel as a strong flow called the Yucatan Current. This current exhibits two basic arrangements inside the GOM. First, the Yucatan Current enters the Gulf and turns immediately eastward, exiting the Gulf towards the Atlantic Ocean via the Florida Straits to become the Gulf Stream. The second arrangement consists of a northward penetration of the Yucatan Current into the Gulf reaching to 26º-28º N. latitudes, then curls clockwise turning south, and exiting via the Florida Straits into the Atlantic Ocean to become, again, the Gulf Stream. The stream inside the Gulf is called the Loop Current. The Loop Current transports warm and salty water year round into the GOM at a rate of 25-30 million cubic meters per second, and it is the main energy source for oceanographic processes inside the Gulf. At its climatic northern position, the Loop becomes unstable, breaks, and sheds a large (200- to 400-km diameter [124- to 248-mi diameter]) clockwise whirlpool that travels southwestwards at speeds of 4-8 km/day (2-5mi/day). The southwest trip of Loop Current eddies continues until colliding with the Texas and Mexico continental slope in the western GOM, where they disintegrate. This sequence connects the eastern with the western Gulf, which otherwise appear disconnected.

Transport of spilled oil during the DWH event exemplifies the various oceanographic processes impacting spilled oil movement and fate. Several different ocean circulation models were utilized during and after the DWH response for tracking oil, forecasting its movement, and now after the spill for hindcasting (e.g., Liu et al., 2011). Of course, all of these models rely on accurate measurements of physical conditions including currents at depth (such as measurements described above) for validating model results. During the blowout, a main concern was the possibility of spilled crude oil entrained in the Loop Current and carried out of the GOM along the sensitive Florida Keys National Marine Sanctuary coral reefs and into the Atlantic Ocean. In reality, the surface spread of the oil was mainly confined to the northern shelf and slope of the GOM and the subsurface plume was primarily transported to the southwestward. In one example of DWH modeling, Adcroft et al. (2010) developed a simple model which included temperature-dependent biological decay of dissolved oil embedded in an ocean-climate model, to simulate the behavior of plumes at depth. They demonstrated that the behavior of the plumes was determined by the combination of sheared current strength and the vertical profile of decay rate. Toxic levels of DWH dissolved oil remained confined to the northern GOM in their model, in part due to biological degradation of oil in the upper layers and very weak currents at depth. Another DWH modeling study was performed by Chang et al. (2011), which did not consider degradation but did use multiyear ensemble analyses of simulated surface and subsurface plume movement. They demonstrated that the reasons for the surface oil spread to be predominantly confined to the northern GOM was because the 2010 wind was more southerly compared with climatology, the Loop Current was predominantly confined to the southern portion of the GOM, and a cyclone existed north of the Loop Current, which tended to produce north and northwestward currents near the spill site.

3.3.5.2. Hurricanes

Climatic cycles in tropical latitudes typically last 20-30 years or even longer (USDOC, NOAA, 2005). As a result, the North Atlantic experiences alternating periods of above-normal or below-normal hurricane seasons. There is a two- to three-fold increase in hurricane activity during eras of above-normal activity. The hurricane activity from 1995 to 2007 is representative of an era of above-normal hurricane activity (Elsner et al., 2008, p. 1,210).

Seventeen hurricanes made landfall in the WPA or CPA during the 1995-2009 hurricane seasons, disrupting OCS oil and gas activity in the Gulf of Mexico (**Table 3-37**). Half of these hurricanes reached a maximum strength of Category 1 or 2 while in the CPA or WPA, while the other half were powerful hurricanes reaching maximum strengths of Categories 4 or 5. The current era of heightened Atlantic hurricane activity began in 1995; therefore, the Gulf of Mexico could expect to see a continuation of above-normal hurricane activity during the first decade to half of the 40-year analysis period and below-normal activity during the remaining half to three-quarters of the 40-year analysis period.

Hurricanes Ivan, Katrina, Rita, Gustav, and Ike caused extensive damage to OCS platforms, topside facilities, and pipeline systems (**Table 3-38**). During Hurricanes Ivan, Katrina, and Rita, 9 jack-up rigs and 19 moored rigs were either toppled or torn from their mooring systems. Sixty platforms were destroyed as a result of Hurricanes Gustav and Ike in 2008; 31 platforms had extensive damage; and 93 platforms had moderate damage (USDOI, MMS, 2008b). The number of destroyed platforms by Hurricanes Gustav and Ike exceeds the number destroyed by Hurricane Katrina. See **Appendix A.3** for statistics for the 2008 Hurricanes Gustav and Ike, and **Chapter 3.2.3** for additional details for pipeline failures caused by hurricanes.

CHAPTER 4

DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

4. DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

Chapter 4 describes the environment that would potentially be affected by the WPA and CPA proposed actions or the alternatives. Resource by resource, this chapter also describes the potential impacts caused by the WPA and CPA proposed actions or alternatives. This EIS was prepared in consideration of the potential changes to the baseline conditions of the environmental, socioeconomic, and cultural resources that may have occurred as a result of the DWH event. The environmental resources include sensitive coastal environments, offshore benthic resources, marine mammals, sea turtles, coastal and marine birds, endangered and threatened species, fisheries, and socioeconomic issues such as recreation, tourism, and employment.

It must be understood that this EIS analyzes the proposed actions and alternatives for the proposed WPA and CPA lease sales. This is not an EIS on the DWH event, although information on this event is being analyzed as it applies to resources in the WPA and CPA.

4.1. WESTERN PLANNING AREA LEASE SALES 229, 233, 238, 246, AND 248

The first proposed WPA lease sale is Sale 229, scheduled to be held in 2012. The WPA sale area encompasses virtually all of the WPA's 28.58 million ac and is located 3 leagues (10 mi; 16 km) offshore Texas and extends seaward to the limits of the United States' jurisdiction over the continental shelf in water depths up to approximately 3,346 meters (m) (10,978 ft) (**Figure 1-1**). As of November 2011, about 21.2 million ac of the WPA sale area are currently unleased. A WPA proposed action would offer for lease all unleased blocks in the WPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(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 nmi north of the continental shelf boundary between the U.S. and Mexico..

Chapter 4.1 presents baseline data for the physical, biological, and socioeconomic resources that would potentially be affected by a WPA 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 WPA lease sale on these resources.

The DWH event off the Louisiana coast resulted in the largest oil spill in U.S. history. Approximately 4.9 million barrels flowed into the Gulf 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 this document was prepared and were applied using accepted methodologies. The BOEM will continue to monitor these resources for effects caused by the DWH event. The Macondo well, however, was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary (**Figure 1-2)**. Data collected by the Operational Science Advisory Team (OSAT) indicate that the DWH spill did not reach WPA waters or sediments (OSAT-2, 2011).

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 WPA proposed action is provided in **Table 3-12**. The mean number of spills >1,000 bbl estimated for a WPA proposed action is <1 spill. Spill rates for several spill-size categories are provided in **Table 3-12**. The probabilities of a spill ≥1,000 bbl occurring and contacting modeled environmental resources are described in **Chapter 3.2.1.8** and **Figures 3-8 through 3-28**.

The potential impacts of a low-probability, catastrophic oil spill such as the one that resulted from the DWH event, to the environmental and cultural resources and socioeconomic conditions analyzed in this EIS are addressed in the "Catastrophic Spill Event Analysis" (**Appendix B**). The reader is referred to **Appendix B** for the analysis of potential effects 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 WPA 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). 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, Fishery Conservation and Management Act, and others are also required.

In order to accomplish this task, BOEM has assembled a multidisciplinary staff, with many of the staff having 20, 30, or even 40+ years of combined 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 and a variety of subsequent postlease NEPA reviews; they 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 WPA 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 utilizing available credible scientific information, and analyses of impacts are 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 mitigating 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 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. This 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 WPA 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 and 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 new scientifically credible information that was available, determined that 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 proposed WPA 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, Military Areas Stipulation, Law of the Sea Convention Royalty Payment Stipulation, and Protected Species Stipulation. Site-specific postlease mitigations may include buffer zones and avoidance criteria to protect sensitive resources such as areas of topographic relief, 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 rerouting pipelines to reduce or eliminate impacts from OCS pipelines that make landfall.

The incomplete or unavailable information identified by the subject-matter experts were grouped into categories that were evaluated to determine whether that information was essential to a reasoned choice among alternatives:

- *Physical Resources in the WPA*: Physical resources (i.e., water quality and air quality) within the WPA were likely not affected to any discernable degree by the DWH event, based on the best available information and the WPA's distance from the Macondo well. At the time this EIS was written, the available data showed that surface oil was present within a measurable radius around Mississippi Canyon Block 252. That radius never extended out to the distance of the WPA perimeter. The Macondo well, however, was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary (**Figure 1-2**). Data collected by the Operational Science Advisory Team indicate that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). 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. Had the water with the depressed dissolved oxygen signature traveled to the WPA, the minimal level of dissolved oxygen depression, combined with the likely ongoing mixing and possible reoxygenation and the fact that areas of depleted oxygen unrelated to the DWH event have been known to occur on the WPA shelf during the summer, when evaluated together, support the assumption that there would be no impact to surface or subsurface water quality in the WPA from the DWH event. During the spill, air data were collected by State agencies at the coastline at locations much closer to the DWH site than the WPA. The small number of samples where DWH contaminants were detected supports the conclusion that elevated air pollutants would have been diluted to background levels prior to reaching the WPA. Therefore, as identified in the resource analyses in this EIS, incomplete or unavailable information regarding physical resources in the WPA may be relevant to reasonably foreseeable significant adverse effects. Unfortunately, much of this information related to the DWH event may not be available for some time, regardless of the costs necessary to obtain this information, as there are numerous task forces and interagency groups involved in the production of the information. It is not expected that this data would become publicly available in the near term, and certainly not within the timeframe contemplated by this NEPA analysis. In any event, BOEM has determined that the information is not essential to a reasoned choice among alternatives.

- *Nonmobile Biological Resources within the WPA*: Coastal and offshore biological and benthic habitats (i.e., barrier beaches, wetlands, seagrasses, soft-bottom habitats, topographic features, chemosynthetic communities, and nonchemosynthetic communities) and nonmobile benthic species that would be expected to spend their entire life cycle in the WPA were likely not affected to any discernable degree by the DWH event, based on the WPA's distance from the Macondo well and currently available data that the spill did not reach WPA waters or sediments. Similarly to the analysis of physical resources in the WPA described in the preceding paragraph, BOEM has determined that the incomplete or unavailable information regarding nonmobile resources is not essential to a reasoned choice among alternatives.

- *Mobile Biological Resources within or Migrating through the WPA*: Certain mobile biological resources (i.e., birds, fish, marine mammals, and sea turtles) having ranges and/or habitats that may include different areas in the Gulf of Mexico may have individually been affected by exposure to oil and/or spill-response activities, provided they were in the vicinity of the DWH event during spill conditions. For several species, scientifically credible information indicates that the biological resources likely to be present in the WPA are either unlikely to have been impacted by the DWH event or have not and are not experiencing chronic stress or persistent adverse effects at the population level. For example, several groups and species of birds in the WPA are unlikely to have been impacted by the DWH event, as their migration patterns indicate they would be unlikely to migrate laterally between the WPA and where the DWH spill occurred. Others, including an endangered bird species, were likely at their summer breeding grounds thousands of miles to the north at the time of the DWH event (**Chapter 4.1.1.14.1**). The extent of recovery of individual species that were potentially adversely affected by the spill and likely to be present in the WPA when exploration activities first occur as a result of a proposed lease sale is uncertain and will depend on the severity, duration, and persistence of the original effect, as well as a given species' resiliency and residual sensitivity. For those individuals and subpopulations, consensus information is still emerging on the magnitudes of these impacts and the length of time for baseline conditions to return to pre-spill conditions.

- *For Impacts from Routine Events*: Although this information would be relevant to a discussion of reasonably foreseeable significant adverse impacts, much of this information may not be available for some time, regardless of the resources necessary to obtain this information, as there are numerous task forces and interagency groups involved in the production of the information. It is not expected that this data would become publicly available in the near term, and certainly not within the timeframe contemplated by this NEPA analysis. Regardless, BOEM has concluded that this incomplete or unavailable information is not essential to a reasoned choice among the alternatives since the adverse impacts from routine activities associated with a WPA proposed action are small, even in light of how baseline conditions may have been changed by the DWH event. It is not essential to a reasoned choice among the alternatives because the subject-matter experts for this EIS have already evaluated the probability and severity of these potential impacts and it is not essential to understand every particular mechanism by which these significant impacts could occur.

- *For Impacts from Accidental or Catastrophic Events*: This EIS acknowledges that very large oil spills could result in significant adverse impacts regardless of the alternative. Impacts from accidental or catastrophic events would result in significant adverse impacts for each of the alternatives. Although relevant and available information on how the DWH event may inform an analysis of impacts of a catastrophic spill is provided in this EIS, additional information may not be available for some time, regardless of the costs necessary to obtain this information, as there are numerous task forces and interagency groups involved in the production of the information. It is not expected that this data would become publicly available during the pendency of this NEPA analysis. However, any incomplete or unavailable information regarding the nature of a very large spill would not be essential to a reasoned choice among the alternatives, with the possible exception of endangered or threatened coastal and marine birds, where incomplete or unavailable information regarding the effects of the DWH event may be essential. A catastrophic spill and its impacts are not "expected" as a result of a WPA lease sale since it remains a low-probability event, particularly in light of improved safety and oil-spill-response requirements that have been put in place since the spill.

- *Endangered and Threatened Species*: The BOEM reinitiated consultation with NMFS and FWS in light of new information that may become available on these species and in light of effects from the DWH event. Pending the completion of the reinitiated ESA Section 7 Consultation, BOEM has prepared an ESA Section 7(d) determination (see 50 CFR 402.09). Section 7(d) of the ESA requires that, after initiation (or reinitiation in this case) of consultation under Section 7(a)(2), the Federal agency "shall not make any irreversible or irretrievable commitment of resources with respect to the agency action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternative measures which would not violate" (Section 7(a)(2)). The BOEM has determined that a WPA proposed action during the reinitiated Section 7 consultation is consistent with the requirements of ESA Section 7(d) because (1) approving and/or conducting these activities will not foreclose the formulation or implementation of any Reasonable and Prudent Alternative measures that may be necessary to avoid jeopardy (or the likely destruction or adverse modification of critical habitat) and (2) the Secretary of the Interior retains the discretion under OCSLA to deny, suspend, or rescind these plans and permits at any time, as necessary to avoid jeopardy. Further, BOEM has determined that the existing completed Section 7 consultation still applies to the remaining lease sales from the *Five-Year Outer Continental Shelf Oil and Gas*

Leasing Program (2007-2012) in the CPA and WPA of the Gulf of Mexico as lease sales alone do not constitute an irreversible and irretrievable commitment of resources. In addition, the results of consultation and any additional relevant information on these species can be employed during postlease activities to ensure that Reasonable and Prudent Alternative measures are not foreclosed.

- *Natural Resource Damage Assessment (NRDA) Data*: In response to the DWH event, a major Natural Resource Damage Assessment is underway to assess impacts to all natural resources in the Gulf of Mexico that may have been impacted by the resulting spill from the Macondo well, as well as impacts from the spill-response operations. The NRDA is mandated by the Oil Pollution Act of 1990 (OPA). The U.S. Department of the Interior is a cooperating agency in the NRDA process, and BOEM is a cooperating agency on a Programmatic EIS being prepared as part of the NEPA analysis for NRDA. However, the NRDA process is being led by the NRDA Trustees, which include NOAA and DOI (FWS and NPS), but not BOEM. The BOEM is not a Trustee, but an "affected party." At this time, limited data compiled in the NRDA process have been made publicly available. Because limited data have been made publicly available, most NRDA datasets are not available for BOEM to use in its NEPA analyses. The BOEM acknowledges that the ability to obtain and use the NRDA data in its NEPA analysis could be relevant to reasonably foreseeable significant adverse impacts; however, the NRDA data are not essential to a reasoned choice among the alternatives. Impacts identified through the NRDA process would likely be the same under any alternative and obtaining this data would not help inform the decisionmaker on a choice among those alternatives. This is because, as discussed above, the adverse impacts associated with a proposed WPA lease sale are small, even in light of how baseline conditions in the WPA may have been changed by the DWH event. The reason the impacts are small 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. Even if the NRDA data were essential to a reasoned choice among the alternatives, it is not publicly available and much of the data may not become available for many years. The NEPA allows for decisions to be made based on available scientifically credible information applied using accepted methodologies where the incomplete information cannot be obtained or the cost of obtaining is exorbitant. The NRDA process is ongoing and there is no timeline on when this information will be released. It is not within BOEM's authority to obtain this information. Cost is not an issue in obtaining the information, regardless of whether the cost would be exorbitant or not. The limitations on the NRDA process, including statutory requirements under OPA, are the determining factor on the availability of this information, not the cost of obtaining it. In light of the fact that the NRDA data may not be available for years, BOEM has used accepted scientific methodologies to evaluate each resource, as described in this chapter. Since the spill, the Gulf of Mexico OCS Region's Environmental Studies Program has continually modified its Studies Plan to reflect this Agency's current information needs for studies that address impacts and recovery from the oil spill. The BOEM's proposed studies attempt to avoid duplication of study efforts yet fill information gaps where NRDA studies may not address particular resources and their impacts from the oil spill. It is unreasonable to delay actions based on information that will not be available for an inordinate length of time, or perhaps will never become available at all.

- *Socioeconomic and Cultural Resources*: Incomplete or unavailable information related to socioeconomic and cultural impacts (i.e., commercial and recreational fishing, recreational resources, archaeological resources, land use and coastal infrastructure, demographics, economic factors, and environmental justice) may be relevant to reasonably foreseeable adverse impacts on these resources. With regard to the DWH event, BOEM has determined that the incomplete or unavailable information would not be essential to a reasoned choice among alternatives. For example, for economic and demographic impacts, the maximum population that could be reasonably foreseen to be impacted by any of the alternatives identified in this EIS is estimated at less than 1 percent of the population in the economic impact area analyzed in the EIS. Therefore, even in light of any change in baseline because of the DWH event, the impact of a WPA proposed action or alternatives would still be exceedingly small.

This chapter has thoroughly examined the existing credible scientific evidence that is relevant to evaluating the reasonably foreseeable significant adverse impacts of a proposed WPA 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).

4.1.1. Alternative A—The Proposed Action

4.1.1.1. Air Quality

The full analyses of the potential impacts of routine activities and accidental events associated with a WPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this EIS. A brief summary of potential impacts follows. Emissions of pollutants into the atmosphere from the routine activities associated with a WPA 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 emissions 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 WPA 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 WPA proposed action would have an insignificant contribution to ozone levels in the nonattainment areas and would not interfere with the States' schedules for compliance with the NAAQS.

4.1.1.1.1. Description of the Affected Environment

The Clean Air Act of 1970 (CAA) established the NAAQS; the primary standards are to protect public health and the secondary standards are to protect public welfare, such as visibility, or to protect vegetation. The current NAAQS are shown in **Table 4-1**. The Clean Air Act Amendments of 1990 (CAAA) established classification designations based on regional monitored levels of ambient air quality. These designations impose mandated timetables and other requirements necessary for attaining and maintaining healthful air quality in the U.S. based on the seriousness of the regional air quality problem.

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. All air-quality nonattainment areas reported in **Figure 4-1** are for ozone nonattainment. In May 2008, the new 8-hour ozone standard NAAQS of 0.075 ppm was fully implemented.

Prevention of Significant Deterioration (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. The PSD maximum allowable pollutant increase for Class I areas are as follows: 2.5 micrograms/cubic meter ($\mu g/m^3$) annual increment for NO_2; 25 g/m^3 3-hour increment, 5 $\mu g/m^3$ 24-hour increment, and 2 $\mu g/m^3$ annual increment for SO_2; and 8 $\mu g/m^3$ 24-hour increment and 4 $\mu g/m^3$ annual increment for PM_{10}. 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, BOEM 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. There is no PSD Class I air quality area in the WPA.

The current NAAQS address six pollutants: carbon monoxide, 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 in the size range from 2.5 to 10 μm (PM_{10}), and fine particulate matter is less than 2.5 μm in size ($PM_{2.5}$). Under the Clean Air Act, 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 few years as more is understood about the effects of the pollutants.

Effective December 17, 2006, USEPA revoked the annual PM_{10} standard and revised the 24-hour $PM_{2.5}$ from 65 $\mu g/m^3$ to 35 $\mu g/m^3$. In early 2008, USEPA promulgated a new, more restrictive NAAQS 8-hour O_3 standard of 0.075 parts per million (ppm), which has been fully implemented.

The USEPA also issued revisions to other NAAQS standards during 2010. Effective April 23, 2010, USEPA revised the NO_2 NAAQS standard to a new 1-hour standard of 100 parts per billion (ppb) (0.100 ppm). Effective August 23, 2010, USEPA established a NAAQS for 1-hour average SO_2 of 75 ppb (0.075 ppm)**.**

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 regional monitored levels of ambient air quality. These designations impose mandated timetables and other requirements necessary for attaining and maintaining healthful air quality in the U.S. based on the seriousness of the regional air quality problem.

When measured concentrations of regulated pollutants exceed standards established by the NAAQS, an area may be designated as a nonattainment area for a regulated pollutant. The number of exceedances and the concentrations determine the nonattainment classification of an area. In the CAAA there are five classifications of nonattainment status—marginal, moderate, serious, severe, and extreme.

The Federal OCS waters' attainment status is unclassified. The OCS areas are not classified because there is no regulatory provision for any classification in the CAA for waters outside of the boundaries of State waters. Only areas within State boundaries are to be classified as either attainment, nonattainment, or unclassifiable.

As of January 22, 2010, the new 1-hour nitrogen dioxide standard of 100 ppb has been fully implemented.

The attainment status for criteria pollutants (CO, SO_2, NO_2, PM, and O_3) for the Gulf Coast States adjacent to the WPA is stated below. Texas is in attainment for the pollutants SO_2 and NO_2. The following Texas inland and coastal counties are classified as nonattainment for ozone: Collin , Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant, in the Dallas-Fort Worth area and Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller in the Houston Galveston Brazoria area (USEPA, 2011b)

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 Clean Air Act (42 U.S.C. 7401 et seq.) and to the extent that activities authorized significantly affect the air quality of any State.

Emission Inventories

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 available in the past few years This Agency 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 non-OCS oil/gas-related emissions. The inventories included carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter-10 (PM_{10}), $PM_{2.5}$, and volatile organic compounds (VOC's), as well as greenhouse gases—carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Another emission inventory study is underway for the year 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 Gas (GHG) 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 GHG Reporting Rule requires operators to report greenhouse gas emissions from general stationary fuel combustion sources to USEPA.

General Conformity Regulations

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

4.1.1.1.2. Impacts of Routine Events

Background/Introduction

The following routine activities associated with a WPA 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 **Chapters 4.1.1.1 and 3.1.1.5**. The impact analysis is based on four parameters—emission rates, surface winds, atmospheric stability, and the mixing height.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. 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 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. 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 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.

Platform emission rates for the GOM region were obtained 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, 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).

Flaring is the burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation 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/testing 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. The potential impacts from these accidental events are discussed in **Chapter 4.1.1.1.3**.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing wind circulation. During summer, the wind regime in the WPA is predominantly onshore during daytime hours 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 WPA is predominantly onshore during the day, OCS activities would not be expected to impact air pollutant levels in Louisiana because any pollutants emitted would be dispersed and recirculated 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 WPA (Florida A&M University, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the vertical space available for spreading the pollutants. The mixing height is the height above the surface 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.

Proposed Action Analysis

The OCS emissions in tons per year for the criteria pollutants as a result of a WPA proposed action are indicated in **Table 4-2**. 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 WPA 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 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.

The VOC emissions 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/Galveston, Port Arthur/Lake Charles, and Baton Rouge areas. Total OCS contributions to O_3 levels at locations where the model predicted O_3 concentrations above the NAAQS) in 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 WPA proposed action would not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller and not interfere with the States' scheduled compliance with the NAAQS (Systems Applications International et al., 1995). Additionally, 30 CFR 250.303(g)(2) requires that, if a facility would significantly impact (defined as exceeding the BSEE significance levels) an onshore nonattainment area, then it would have to reduce its impact fully through the application of the best available control technology and possibly through offsets as well. The new 8-hour ozone standard (0.075 ppm) has been fully implemented as of May 27, 2008. It is more stringent than the previous 1-hour standard, as well as the old 8-hour standard. In response to the1997 ozone standard (this was true when the new standard was 0.08 ppm), 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 to 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.

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 produced pursuant to a WPA proposed action 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 through administrative code by the States of Louisiana and Texas.

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 may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute to the visibility impairment in the Gulf coastal areas. Since future air emission from all sources in the area are expected to be about the same level as they have been or less, it is expected that the impact on visibility due to the presence of fine particulates would be, as previously determined, minor.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the routine activities associated with a WPA 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. Emissions from proposed-action activities are expected to be well within the NAAQS. As indicated in the GMAQS and other modeling studies, a WPA 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 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. Regulations, monitoring, mitigation, and developing emissions-related technologies would ensure these levels stay within the NAAQS.

4.1.1.1.3. Impacts of Accidental Events

Background/Introduction

The accidental release of hydrocarbons related to a WPA proposed action would result in the emission of air pollutants. The OCS accidents would 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, hydrogen sulfide, and methane. These pollutants are discussed in **Chapter 4.1.1.1.2** above. If a fire were 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 or a "spill of national significance." An analysis of the impact of a catastrophic spill is included in **Appendix B**. Many Federal and State agencies and companies participate in response to a catastrophic event such as the DWH event. Air quality onshore and on-water was monitored by the Occupational Safety and Health Administration (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 such as http://www.epa.gov/bpspill/air.html.

Proposed Action Analysis

The accidental release of hydrocarbons or chemicals from a WPA 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_x, 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 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 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.

Hydrocarbons

Oil is a mixture of many different chemical compounds, some of which are hazardous to human health. Toxic chemicals can cause headache or eye irritation. Benzene can cause cancer at high levels and long exposures. The benzene, ethylbenzene, toluene, 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 of 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 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**.

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. There has been some evidence that petroleum from deepwater contain 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. Hydrogen sulfide 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 Hydrogen Sulfide NTL (NTL 2009-G31) require a Contingency Plan as well as sensors and alarms 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 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 results showed that the surface concentrations of particulate matter did not exceed the health criterion (at that time) of 150 $\mu g/m^3$ beyond about 5 km (3 mi) downwind of an in-situ burn. This is quite conservative as 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) where dioxins and furans could 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, thus, concerns about eventual dioxin bioaccumulation in seafood were alleviated.

Flaring

Flaring may be conducted to manage excess natural gas during an accidental event such as damage to a pipeline that transports the gas to shore. 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. In-situ burning and flaring are temporary efforts to limit environmental impact during an accidental spill. The appropriate agencies will monitor for worker safety. Pollutant concentrations onshore would be expected to be within the NAAQS and not 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 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.

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.

Summary and Conclusion

Accidental events associated with a WPA proposed action that could impact air quality include spills of oil, natural gas, condensate, and refined hydrocarbons; H_2S release; fire; and 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. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. 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.

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.

4.1.1.1.4. Cumulative Impacts

Background/Introduction

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

The activities in the cumulative scenario that could potentially impact onshore air quality include a WPA proposed action and the OCS Program; State oil and gas programs; other major factors influencing offshore environments; onshore non-OCS activities; accidental releases from an oil spill; accidental releases from hydrogen sulfide; natural events (e.g., hurricanes); and a catastrophic oil spill.

The activities for the OCS Program include the drilling of exploration, delineation, and development wells; platform installation; and 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 from OCS activities are estimated to be within PSD Class II allowable increments. 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). The OCS contribution to the air quality problem in the coastal areas is small, but the total impact from onshore and offshore emissions would be significant to the ozone nonattainment areas in southeast Texas and the parishes near Baton Rouge, Louisiana.

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 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 other efforts, 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, a more stringent air quality standard has recently been implemented by USEPA, which may result in increasing the number of parishes/counties in the coastal states in violation of the Federal ozone standard. There is also a proposal to further decrease the ozone standard. If the ozone standard was lowered, although OCS emissions from a WPA proposed action would not vary, the OCS emissions in those newly designated areas would have an incrementally larger contribution to the onshore ozone levels. Although air quality is improving, the number of areas in nonattainment could increase due to more stringent standards (USEPA, 2010b).

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, volatilization 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 hydrogen sulfide is described in **Chapter 3.1.1.9.1**. The same safety precautions and regulations described in a WPA proposed action are applicable to the cumulative scenario. That is, a typical safety zone of several kilometers is usually established in an area with the concentration of hydrogen sulfide greater than 20 ppm from the source or a platform.

The effects of hurricanes on the offshore infrastructure are described in **Chapters 3.1.1.9.3 and 3.3.7.2**. Hurricanes mainly cause damage to offshore infrastructures and pipelines, which may result in an oil spill. For the cumulative scenario, the emissions from oil-spill and repair activities are expected to be the same as a WPA proposed action and to have minimum effects on the onshore air quality.

The impacts of accidental events and the DWH event are briefly described in **Chapter 4.1.1.1.3 and Appendix B**. The DWH event may have the potential to cause effects on air quality and public health and the environment, which may occur from the application of dispersants to an oil spill, in-situ oil burning, evaporation of toxic chemicals from oil spill, and cleanup activities.

These events will release and transport the 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.

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 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.

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 Gullett, 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.

However, at 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.

The effects of DWH event on public health and the environmental can be classified as the short-term and long-term effects. The short-term effect includes watery and irritated eyes, skin itching and redness, coughing, and shortness of breath or wheezing. As yet, little is know about the long-term health effects of direct exposure to the DWH event. Past accidental events of oil spills do not provide guidance for the assessment of the long-term impact of DWH event on public health.

A survey of major 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. Several previous major oil spills are described below.

The large oil-spill incidents include the *Ixtoc I* oil spill accident in the Bay of Campeche of the Gulf of Mexico on June 3, 1979; the *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 and was finally capped on March 23, 1980. Ocean currents carried the oil and 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 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.

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 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 from OCS activities are estimated to be within PSD Class II allowable increments. The modeling results indicate that the cumulative impacts to a PSD Class I Area are well within the PSD Class I allowable increment (Wheeler et al., 2008).

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.

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 WPA proposed action (as analyzed in Chapter **4.1.1.1.2**) to the cumulative impacts would not significantly affect coastal nonattainment areas. The cumulative contribution to visibility impairment from a WPA proposed action would also not be significant.

There are only limited studies on the long-term impact of air quality on human health and the environment in the history of oil spills. Each incident is different and exposure factors vary. Therefore, the long-term effects on human health and the environment are still unknown.

4.1.1.2. 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 4-1**). 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 WPA 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 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.

Small spills (<1,000 bbl) are not expected to significantly impact water quality in coastal or offshore waters. Large spills (≥1,000 bbl), however, could impact water quality in coastal waters. Accidental chemical spills, release of SBF's, and blowouts could have temporary localized impacts on water quality.

The activity associated with a proposed action could contribute a small percentage of the existing and future OCS oil and gas activities. The specific discharges, drill muds, cuttings and produced water, and accidents resulting in spills would occur in proportion to production and, therefore, would 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.

4.1.1.2.1. Coastal Waters

4.1.1.2.1.1. 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 4.1.1.4**. 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 rivers 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; this effect is cumulative as the river reaches an estuary (Gore, 1992, pp. 280 and 291). Overenrichment of nutrients may lead to eutrophication, which 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 4.1.1.4 and 4.1.1.5**, 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 components into the GOM through waterbodies emptying into the GOM, runoff, groundwater discharge, or precipitation. 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. The study of water quality may also examine possible pollutants such as metals and organic compounds. Water quality in coastal waters of the northern Gulf of Mexico is highly influenced by season. For example, salinity in open water near the coast may vary between 29 and 32 practical salinity units (psu) during fall and winter, but it may decline to 20 psu during spring and summer due to increased runoff (USDOI, MMS, 2000a). Oxygen and nutrient concentrations also vary seasonally.

The priority water quality issues identified by the Gulf of Mexico Alliance are as follows: (1) reducing the risk of exposure to disease-causing pathogens; (2) minimizing the 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. 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 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 million barrels of oil were released during the event (Oil Spill Commission, 2011c), 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, 2011d). As well, the corresponding emission of methane from the wellhead during the incident was estimated between 9.14×10^9 and 1.25×10^{10} moles (Kessler et al., 2011). 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, 2011c, 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 (proxies for 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). Thus, based on these observations, few (if any) water quality impacts on the WPA itself by the DWH event have been documented thus far.

4.1.1.2.1.2. Impacts of Routine Events

Background/Introduction

The scenario information related to a WPA proposed action is presented in **Table 3-2**. The routine activities associated with a WPA 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 WPA proposed action, but a WPA proposed action would contribute to maintenance dredging of existing navigation canals. Maintenance dredging will 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 WPA proposed action are 64,000-75,000 trips over the 40-year life of a proposed action (**Table 3-2**). Based on current service-base usage, it is assumed the majority of these trips would occur in Texas' coastal waters. The types of discharges and regulations are discussed in **Chapter 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 WPA proposed action. In addition, a WPA proposed action would contribute to the use of existing onshore facilities in Texas, Louisiana, and possibly Mississippi and Alabama. 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 due to existing regulations, 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. The impacts to coastal water quality from routine activities associated with a WPA proposed action should be minimal because of the distance to shore of most routine activities, USEPA regulations that restrict discharges, and the few, if any, new pipeline landfalls or onshore facilities that would be constructed.

4.1.1.2.1.3. Impacts of Accidental Events

Background/Introduction

Accidental events associated with a WPA 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 1.25×10^{10} moles of methane from the wellhead (Kessler et al., 2011), with subsurface methane concentrations as high as ~300µM (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 4.1.1.15.3**).

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 3.2.1.7.1** 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 will reduce the amount of oil. **Chapter 3.2.1.9** provides a further discussion of oil-spill-response considerations. Coastal water quality will 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, 2011d). The most heavily used dispersant formulation 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 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 detections 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). 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.

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 will depend 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 would be similar to those 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, 2006b). 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 offshore water quality are not expected to be significant.

Summary and Conclusion

Accidental events associated with a WPA 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, spills of chemicals or drilling fluids, loss of well control, pipeline failures, collisions, or other malfunctions that would 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 will 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 the spill is in and the proximity of the spill to shore. 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. Spills from collisions are not expected to be significant because collisions occur infrequently.

4.1.1.2.1.4. 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 will have some of the same specific impacts (e.g., vessel traffic will occur for all of these 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 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 Louisiana and Texas rivers contribute to seasonal formation of hypoxic zones on the Louisiana and Texas shelf. The USEPA has regulatory programs designed to protect the waters that enter the Gulf. The USEPA has authorized the Gulf Coast States to administer the State NPDES programs. Additionally, the Gulf Coast States evaluate water quality through the Total Maximum Daily Load (TMDL) program (CWA, Section 303d) and the Water Quality Assessment program (CWA, Section 305b). 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 will 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 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. 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**). The effect on coastal water quality from spills estimated to occur from a 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 will reduce the amount of oil. See **Chapter 3.2.1.9** for further discussion of oil-spill-response considerations. Coastal water quality will 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 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 WPA 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. Since a catastrophic OCS Program-related accident would be both rare and not expected to occur in coastal waters, the impact of accidental spills is expected to be small. The effect on coastal water quality from smaller accidental spills is expected to be minimal relative to the cumulative inputs of hydrocarbons from other sources. The incremental contribution of the routine activities associated with a proposed action to the cumulative impacts on coastal water quality is not expected to be significant.

4.1.1.2.2. Offshore Waters

4.1.1.2.2.1. 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 rivers emptying into the Gulf bring freshwater and sediment into coastal waters (Gore, 1992, pp. 127-131), which affects the water quality of these 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 to 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 parts per thousand (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 to 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).

A study was funded by this Agency to understand the processes that maintain oxygen levels in the deep Gulf of Mexico (Jochens et al., 2005). This study showed that dissolved oxygen enters the upper waters (~100-200 m; 328-656 ft) of the Gulf of Mexico through the atmosphere and photosynthesis. 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. The Gulf of Mexico does not have watermass formation to replenish the deep oxygen concentrations. Thus, the deep circulation of the Gulf of Mexico and its related mixing are the mechanisms that replenish the deep oxygen. Oxidation of organic matter is the major oxygen sink in the Gulf of Mexico. The Gulf of Mexico has an oxygen minimum zone, which is generally located from 300 to 700 m (984 to 2,297 ft).

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 areal extent of mid-summer hypoxia has ranged from 40 to 22,000 km^2 (15 to 8,494 mi^2) and has averaged approximately 13,500 km^2 (5,212 mi^2) during 1985-2007 (Greene et al., 2009). The hypoxic conditions last until local wind-driven circulation mixes the water again. The 2010 dead zone covered 20,000 km^2 (7,722 mi^2), making it one of the largest ever (LUMCON, 2010a). Variability in the mid-summer hypoxic area was modeled using riverine discharge, nitrate loading, and total phosphorus loading, and it resulted in hypoxia area predictions to within ±30 percent (Greene et al., 2009).

Separate zones of hypoxia have been discovered 5-15 mi (8-24 km) off the coast of Texas and are 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, 2010b).

The priority, water quality issues identified by the Gulf of Mexico Alliance are (1) reducing the 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, which are located in offshore waters of the Gulf of Mexico. Hydrocarbons enter the Gulf of Mexico through natural seeps 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). The numbers in this paragraph were generated from converting the units reported in the noted reference.

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).

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 and Kennicutt, 1988). Continental Shelf Associates, Inc. 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, synthetic-based fluid (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 site, 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 from 232 to 279 nanograms/gram, respectively. At this site, sediment cadmium concentrations did not change significantly following exploratory drilling.

The condition of offshore waters of the Gulf of Mexico was altered by the DWH event and associated oil spill. The Government estimated that approximately 4.9 million barrels of oil were released during the event (Oil Spill Commission, 2011c), 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, 2011d). As well, the corresponding emission of methane from the wellhead during the event was estimated between 9.14×10^{9} and 1.25×10^{10} moles (Kessler et al., 2011). In shelf waters, surface water oiling stretched from a maximum westward extent at roughly the Louisiana-Texas border to an eastward extent around Apalachicola, Florida (Oil Spill Commission, 2011c, Figure 7.1). Surface oiling was also observed stretching southward from the spill site, farther over deep waters, as oil was advected by cyclones at the northern edge of the Loop Current (e.g., USDOC, NOAA, 2010b). To date, oil from the DWH event has not been identified as having entered the Loop Current. As well, a subsurface oil and gas plume was discovered in deep waters between ~1,100 and 1,300 m (e.g., Diercks et al., 2010). Based on in-situ fluorescence and oxygen measurements (proxies for 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). Thus, based on these observations, few (if any) offshore water quality impacts have been documented thus far on the WPA itself by the DWH event.

Offshore water quality will 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 synthetic-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).

4.1.1.2.2.2. Impacts of Routine Events

Background/Introduction

The scenario information related to a WPA proposed action is presented in **Table 3-2**. The routine activities associated with a WPA 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.

Proposed Action Analysis

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 it will expire on September 30, 2012.

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 and the impacts of discharge are discussed in greater detail in **Chapter 3.1.1.4.1**. A WPA proposed action is projected to result in the drilling of a total of 53-89 exploratory and delineation wells and 77-121 development and production wells (**Table 3-2**). 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's 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. Because these oils often contain toxic materials such as PAH's, the discharge of OBM's or cuttings wetted with OBM is prohibited, and these muds are now rarely used in deepwater operations and only occasionally are 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 and the impacts of discharge are discussed in greater detail in **Chapter 3.1.1.4.2**. The scenario for the WPA projects that 77-121 development and production wells will be drilled, of which 27-40 are expected to be producing oil wells and 36-62 are expected to be producing gas wells (**Table 3-2**). 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.

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 and the impacts of discharge 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 WPA proposed action is projected to result in the installation of 15-23 structures and the removal of 14-22 structures (**Table 3-2**). A WPA proposed action is also projected to result in the installation of 237-554 km 147-344 mi) of pipeline. Additional information on bottom-area disturbance and a description of 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 following is stated:

> 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 will 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 WPA proposed action is projected to result in 64,000-75,000 service-vessel round trips (**Table 3-2**). A marine sanitation device is required to treat sanitary waste generated on the service vessel so that surrounding water will not be impacted by possible bacteria or viruses in the waste (40 CFR 140 and 33 CFR 159). The discharge of treated sanitary waste will 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, though less likely, ballast water. The regulations for the control of oil discharges are in 33 CFR 151.10. These 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 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).

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. Impacts to offshore waters from routine activities associated with a WPA proposed action should be minimal.

4.1.1.2.2.3. Impacts of Accidental Events

Background/Introduction

Accidental events associated with a WPA 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 WPA 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., 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.

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 and 1.25×10^{10} moles of methane from the wellhead (Kessler et al., 2011), with subsurface methane concentrations as high as ~300μM (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 4.1.1.15.3**).

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. **Chapter 3.2.1.5** presents the risk of offshore spills associated with a WPA 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). 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.

Oil-Spill Response and Chemical Dispersants

In the case of an accidental event, it is likely that response efforts will 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 will 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.

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, 2011d). The most heavily used dispersant formulation 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). Sediment and water samples collected in the offshore and deepwater zones were analyzed for a number of dispersant-related chemicals, but predominantly Dipropylene Glycol n-Butyl Ether (DPnB) (OSAT, 2010). Between mid-June and mid-October, 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; 3,609-4,625 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. 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.

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 will 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, 2009b); 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 will 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 may be discharged, but those discharges are regulated by USEPA through NPDES permits. Water-based muds 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 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; 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, 2010i), 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. 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 (USDOI, BOEMRE, 2010e), 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 WPA 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. 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 (**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 degradation processes will also decrease the amount of spilled oil over time. 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.

4.1.1.2.2.4. 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 will also affect offshore environments. Many of these categories will have some of the same specific impacts (e.g., vessel traffic will occur for all of these categories 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 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 Texas and Louisiana rivers contribute to seasonal formation of hypoxic zones on the Texas and Louisiana shelf. The USEPA also regulates point-source discharges. The USEPA has various regulatory programs designed to protect the waters that enter the Gulf (**Chapter 4.1.1.2.1.4**). 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 will 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, 2007a). 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 re-cycling (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 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**. 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 4.1.1.2.2.3** 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 will reduce the amount of oil. See **Chapter 3.2.1.9** for further discussion of oil-spill-response considerations. Offshore water quality will 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 proposed action and the OCS Program, the activities of other Federal agencies (including the military), 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). The impacts resulting from a WPA 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. Since a catastrophic accident is rare, the impact of such accidents is expected to be small. The incremental contribution of the routine activities associated with a proposed action to the cumulative impacts on coastal water quality is not expected to be significant.

4.1.1.3. Coastal Barrier Beaches and Associated Dunes

The full analyses of the potential impacts of routine activities and accidental events associated with a WPA 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 WPA proposed action, such as increased vessel traffic, maintenance dredging of navigation canals, and pipeline installation, would cause negligible impacts and will 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 WPA proposed action are anticipated to be minimal. The incremental contribution of a WPA proposed action to the cumulative impacts to coastal barrier beaches and associated dunes is expected to be small.

4.1.1.3.1. Description of the Affected Environment

The coastal environments discussed here are those barrier beaches and associated dunes that might be impacted by activities resulting from a WPA proposed action. Geographically, the discussion covers coastal areas that range from the Texas/Louisiana border to the State of Tamaulipas, Mexico. Although seemingly similar biological environments occur in each of those subareas, they vary significantly. For that reason, the following environmental descriptions of this coast are organized into two geologic subareas: (1) the barrier island complex of northern Tamaulipas, Mexico, and southern Texas; and (2) the Chenier Plain of eastern Texas. Tidal influences can be seen 25-40 mi (40-64 km) inland in some areas of Texas due to large bay complexes, channelization, and low topographies. Wind-driven tides are often dominant over the minimal gravity tides that occur there.

The WPA has been subjected to increased frequency and intensity of hurricanes since the last description and analysis of the environment was prepared for the WPA. In addition, the largest oil spill (DWH event) in U.S. Federal waters has occurred off the adjacent Louisiana coast. As a result of these natural and manmade factors (hurricane-induced damage in combination with hurricane protection works), the existing condition of the barrier and beach resources has been altered. Based on currently available information and the proximity of the DWH event from the Texas beach and barrier resources, there has been no indication of negative affect of the DWH event on these resources. The descriptive narrative of the existing condition of the resources includes a brief insight into barrier island and beach formation and also highlights the changed environment of some of these resources as a result of the various natural (hurricanes) and manmade (DWH event) forces that define the present state of the resource.

Barrier islands make up more than two-thirds of the northern Gulf of Mexico shore. Each of the barrier islands is either high profile or low profile depending on the elevations and morphology of the island (Morton et al., 2004). 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 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 will 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. These influences are discussed in the cumulative impact analysis (**Chapter 4.1.1.3.4**). 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.

Barrier islands, particularly vegetated ones with freshwater and or saltwater pools, may serve as habitat for a wide variety of animal life, especially birds. The islands and spits protect the bays, lagoons, estuaries, salt marshes, seagrass beds, and other wetland environments, some of which may contain threatened or endangered species.

The barrier islands from Texas to Louisiana all incurred some type of damage from the combination of Hurricanes Katrina, Rita, Gustav, and Ike and in some cases in combination with Hurricane Wilma as well. Hurricane Katrina in August 2005 caused severe erosion and landloss for the coastal barrier islands of the deltaic plain. 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 several major storms occur within a short time period.

Each of the barrier islands is either high profile or low profile depending on the elevations and morphology of the island (Morton et al., 2004). The height and continuity of these elevations determine the ability of the barriers to withstand storm-surge flooding and overwash. Barrier islands, particularly vegetated ones with freshwater and or saltwater pools, may serve as habitat for a wide variety of animal life, especially birds. The islands and spits protect the bays, lagoons, estuaries, salt marshes, seagrass beds, and other wetland environments, some of which may contain threatened or endangered species.

Upper Texas Coast

The barrier islands along the northeast Texas coast were severely eroded, losing 1 ft (0.3 m) in elevation and retreating landward 98 ft (30 m) between 2001 and 2005, as a result of a combination of Hurricanes Katrina and Rita and other previous storms (Newby, 2007). The overall analysis showed gains and losses along the barrier beaches, with a general landward retreat; however, in some areas, a parallel strip of elevation gain is also noted. In these areas, the material from the beach was overwashed landward of the beach ridge with sediment deposited into low-lying areas. The McFaddin National Wildlife Refuge, Texas Point National Wildlife Refuge, Sea Rim State Park, and J.D. Murphree State Wildlife Management Area comprise the McFaddin Complex, which contains approximately 60,000 ac (24,280 ha) of coastal marsh (i.e., fresh, intermediate, and brackish), coastal prairie (nonsaline and saline), coastal woodlands, and beach/ridge habitats in Jefferson and Chambers Counties in southeast Texas (USDOC, NMFS and USDOI, FWS, 2007a). The beaches and ridges along the McFaddin Complex were already experiencing a historic erosion rate of 5-7 ft/yr (1.5-2.1 m/yr) prior to Hurricanes Katrina and Rita. Post-Hurricane Rita, a remnant dune/beach system still exists, although much has been lost through erosion and shoreline retreat, leaving only a low-lying, washover terrace. Loss of the existing beach dunes and the lowering of beach ridge elevations along the Gulf shoreline of the McFaddin Complex from Hurricane Rita puts approximately 30,000 ac (12,146 ha) of nationally significant wetlands at risk for saltwater intrusion (Doran et al., 2009).

Recent long-term retreat along the upper Texas coast has been reported at rates of 3-15 ft/yr (1-5 m/yr). Shorelines of area bays are eroding at rates averaging 2 ft/yr (61 cm/yr), but in some places as much as 10 ft/yr (305 cm/yr). However, along these same reaches there are “swash” zones where the back and forth action of the waves pick up and deposit sand on the beach face. Landward of these "swash zones" is the main beach or "storm beach" only reached by storm tides (Anderson, 2007). The large amount of sand moved up on the beaches eventually forms a series of beach ridges and dunes. It is these topographic features that protect the coast from washover. However, as the beach moves landward, the dune system moves with it. The same orbital motion in the nearshore "swash zone" that efficiently transports sand beachward is also at work in the deeper nearshore waters of the upper Texas coast. The wave amplitude in these deeper waters creates an even more efficient transport system in this offshore "swash zone" and makes it very efficient as a sediment transport mechanism. It is because of this action that a series of bars and depressions called runnels are formed along the coast.

The prevailing winds along the upper coast approach from the southeast, while the sand-bearing longshore currents run east to west. These longshore currents bring the much needed sand to shore and nourish the beaches. Weather systems from November to March cause winds along the upper coast that blow from the shore Gulfward, dampening the effect of the sand transport from the longshore currents. The winds shift in northerly and southeasterly directions causing higher tides; therefore, beaches expand and contract accordingly. Along the upper Texas coast, not only is the beach retreating, but the shoreface is also retreating at the same rate as the beach (Anderson, 2007). The sand from the old deltas formed during the fall of sea level, replenishing the receding beaches along the newly evolving coast. As these coastal processes evolve in combination with manmade modifications, the coast becomes more vulnerable to storms and tidal surge.

Texas and Mexican Barrier Island Complex

The Gulf coastline of Texas is about 367 mi (590 km) long. The State of Tamaulipas, in northeastern Mexico, has a Gulf coastline of about 235 mi (378 km). The barrier islands of both areas are mostly accreted sediments that were reworked from river deposits, previously accreted Gulf shores, bay and lagoon sediments, and exposed seafloors (White et al., 1986). This reworking continues today as these barrier beaches and islands move generally to the southwest (Price, 1958). During the period from about 1850 to 1975, net coastal erosion occurred in the following three groups of counties in Texas: (1) Cameron, Willacy, and southern Kennedy; (2) northern Matagorda, Brazoria, and southern Galveston; and (3) Jefferson, Chambers, and far northern Galveston (Morton, 1982). These generalized trends seem to be continuing. Padre Island is moderately regressive; the shoreline is retreating and more land is being exposed. It is typically 5-10 ft (1.5-3 m) above sea level and occasionally overwashed by hurricane surges. On the northern portion, some dunes may rise 20-30 ft (6-9 m), and the dune ridge is generally continuous. On the southern portion, the dune ridge is a series of short discontinuous segments. The dry winds and arid nature of this southern portion destabilize sand dunes. Sand flats and coppice dunes (small windblown sand mounds that form behind vegetation such as small shrubs) occupy the southern portion of the island. Any activity that reduces the sparse vegetation cover of this area initiates erosion. Vegetation on Padre Island is generally sparse, becoming sparser on its southern portion. The vegetation largely consists of grasses and scrubby, woody growth (Brown et al., 1977).

Exceptions to the above are the once regressive Matagorda Peninsula and Rio Grande Headland. The Matagorda Peninsula accreted as the Brazos-Colorado River Delta. Later, the peninsula became transgressive and the sediments were reworked to form flanking arcs of barrier sand spits. Washover channels cut the westward arc of the peninsula, forming barrier islands. The Rio Grand Headland has also become transgressive, and sand spits formed to its north and south. Today, longshore drift is southerly at these sites. Their northern spits are now eroding and their southern spits are accreting. Padre Island is moderately regressive; the shoreline is retreating and more land is being exposed. It is typically 5-10 ft (1.5-3 m) above sea level and occasionally overwashed by hurricane surges. On the northern portion, some dunes may rise 20-30 ft (6-9 m), and the dune ridge is generally continuous. On the southern portion, the dune ridge is a series of short discontinuous segments. The dry winds and arid nature of this southern portion destabilize sand dunes. Sand flats and coppice dunes occupy the southern portion of the island. Any activity that reduces the sparse vegetation cover of this area initiates erosion. Vegetation on Padre Island is generally sparse, becoming sparser on its southern portion. The vegetation largely consists of grasses and scrubby, woody growth.

The barrier islands along the northeast Texas coast were severely eroded, losing 1 ft (0.3 m) in elevation and retreating landward 98 ft (30 m) between 2001 and 2005, as a result of a combination of

Hurricanes Katrina/Rita and other previous storms (Newby, 2007). The beaches of Galveston Island and Bolivar Peninsula are locally eroding or accreting. Accreting shorelines have a distinct beach berm and a wide back beach. Eroding beaches are relatively narrow, and the beach berm and back beach may be absent. Construction of seawalls and jetties on Galveston Island has contributed to erosion there. While the Texas coast was spared major damage from Hurricane Gustav, it took the brunt of Hurricane Ike. The most extensive damage occurred on the Bolivar Peninsula as a result of the overtopping of dunes and breeching beach ridges, resulting in reduced dune height or, in some cases, the removal of the dunes completely. Closer to the location of peak surge, just east of High Island, Texas, the flood waters were high enough to completely submerge the barrier islands as the surge flowed rapidly back into the Gulf of Mexico. Dune-height changes exceeding 3 ft (1 m) were observed more than 32 mi (60 km) to the east of the landfall position, while dune-height changes exceeding 3 ft (1 m) were observed as far as 25 mi (40 .km) to the west of landfall. In Galveston, Texas, the seawall is considered to be the dune crest and the elevation change is roughly 12 in (30 cm), which is consistent with the previously determined vertical offset. Galveston Island had partial seawall protection along the beach front, lessening the erosion of shoreface to areas in front of the seawall. On the sandy beaches west of the seawall, peak dune elevations before the storm were 7-13 ft (2-4 m), roughly half of the elevation of the seawall. The coastal change along this unprotected stretch of Galveston Island was considerably more than on the sea-walled section nearby, but it was less than the visible impacts on the Bolivar Peninsula.

Shoreline erosion of 492 ft (150 m) was observed near Gilchrist, Texas. More than 164 ft (50 m) of shoreline erosion was experienced over a wide region from the seawall, extending 9 mi (15 km) to the west. The area of positive shoreline change at the south end of Galveston Island is related to spit formation at San Luis Pass and may not be related to Hurricane Ike. The area of positive shoreline change 50 mi (80 km) to the east of landfall is due to the seaward transport of sediment as storm water drained from the marshes (Doran et al., 2009). Only general, qualitative damage assessments using aerial photography have been prepared to date by USGS for impacts associated with Hurricane Gustav.

Other upper Texas beaches and lagoons affected by the hurricane surge of Ike include the wildlife refugees along the Texas coast and the J.D. Murphree State Wildlife Management Area, which received the most substantial damage to dunes, beaches, and marsh ponds. West of Hurricane Ike's landfall, the differences in the storm surge, winds, and waves, as well as higher coastal elevations, all worked together to lessen the storm's impact on the coast.

Chenier Plain

The Chenier Plain of eastern Texas and western Louisiana began developing about 2,800 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, forming a shoreface that slopes very gently, almost imperceptibly, downward for a very 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, causing 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 this coast to transgressive shorelines.

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, which generally move slowly westward along the coast.

The barrier beaches of the Chenier Plain are generally narrow, low, and sediment starved due to the natures of coastal currents and the shoreface. Here and there, beach erosion has exposed relic marsh terraces that were buried by past overwash events. West of about Fence Lake, Texas, the beach is fairly typical, being composed of shelly sand; although, it is no more than 200 ft (61 m) wide. Its shoreface sediments are similar to those shelly sands found in the upper portion of the shoreface (Fisher et al., 1973). East of Fence Lake, the shoreface contains discontinuous mud deposits among muddy sands. During low tides, extensive mudflats are exposed east and west of Fence Lake. The beach in this area is much narrower and becomes a low escarpment, where wave action cuts into the salt marsh (Fisher et al., 1973). Hurricane Rita (September 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 20 ft (6 m) caused beach erosion and overwash, which flattened coastal dunes depositing sand and debris well into the backing marshes.

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 U.S. The spill was approximated at 4.9 million barrels; 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. The available information presented here is primarily from television news, magazines, and newspaper 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 Shoreline Cleanup and Assessment Teams (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, little 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 SCAT observation maps (as of September 28, 2011) and data available from interviews of local scientists participating in the oil response effort. It should be noted, however, that the effects of the DWH event on WPA (Texas) barrier beaches and associated dunes were minimal compared with the effects of that event on those resources in the CPA**.** Based on currently available information, the only oiling incident reported on the Texas beaches was the sighting of small tarballs washed ashore along the Bolivar Peninsula as reported by Coast Guard Commander Marcus Wooding (Lozano, 2010).

4.1.1.3.2. Impacts of Routine Events

Background/Introduction

This section considers impacts from routine activities associated with a WPA proposed action to the physical shape and structure of barrier beaches and associated dunes. The major routine impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, and construction and expansions of navigational canals and port facilities (**Chapter 3.1**).

Although remnant oil was detected intermittently in the Gulf environment as a result of the DWH event in the fall of 2010, the only DWH oil verified in the WPA was the small amount of tarballs that reached some small area beaches along the Bolivar Peninsula. 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 treatment.

This section considers impacts from routine activities associated with a WPA proposed action to the physical shape and structure of barrier beaches and associated dunes. These activities include pipeline emplacements, navigation channel use (vessel traffic), dredging, and construction of support infrastructure.

Pipeline Emplacements

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Pipeline landfall sites on barrier islands could accelerate beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from pipeline landfalls that employ modern installation techniques, such as directional boring (LeBlanc, 1985; Mendelssohn and Hester, 1988; Wicker et al., 1989).

Vessel Traffic and Dredging

Vessel traffic that may support a WPA proposed action is discussed in **Chapter 3.1.1.8.4**. Navigation channels projected to be used in support of a WPA 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 WPA 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. These processes are due to shoreline and hydrological changes resulting from localized subsidence and passages of seasonal and tropical storms. 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. A more recent study by Thatcher et al. (2011) has demonstrated canal erosion rates slowing in recent years, noting the average canal widening rate of -0.99m/year (-3.25 ft/year) for the 1996-1998-2005/2006 time period compared with -1.71 m/year (-5.61 ft/year) for the earlier 1978/1979-1996/1998 time period. This study, unlike the earlier studies by (Johnson and Gosselink, 1982), considered vegetative cover and substrate in addition to armoring, which has occurred in some of the navigation canals and was not previously considered. If a navigation channel is too large for storm/tidal exchange to keep it clear, it would generally capture and remove sediment from longshore drift with sandbars. Periodic maintenance dredging is expected in existing navigation channels through barrier passes and associated bars. Jetties or bar channels (from maintenance dredging) serve as sediment sinks by intercepting sediment in longshore drift. Dredging removes sediment from the littoral sediment drift or re-routes sediment around the beach, which is immediately downdrift of the involved channel. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby ocean dumping sites in the Gulf, or they are now used for beneficial uses such wetlands or beach renourishment projects.

Continued Use of Support Infrastructure

No onshore infrastructure used to support OCS operations has been constructed recently on barrier beaches in Texas or Louisiana. The use of some existing facilities in support of a WPA proposed action 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. They may also cause the accumulation of sediments updrift of the structures. Those sediments might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In 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 that can continue after the structure is removed if the hydrodynamics of the area are permanently modified. Recent successive hurricanes (Katrina, Rita, Gustav, and Ike) have damaged barrier islands along the Texas and Louisiana coasts, have accelerated erosion, and have undermined pipelines and support structures in some areas. Expansions of existing facilities located on barrier beaches or 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. All 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 WPA proposed action. Should one be constructed, it would most likely be in the northeastern coast of Texas, where the large majority of the pipelines from the WPA come ashore. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, Federal and State regulatory programs and permitting processes encourage the use of directional boring technology to greatly reduce and perhaps eliminate impacts to barrier beaches or dunes. Therefore, effects on barrier beaches and dunes from pipeline laying activities associated with a WPA proposed action are expected to be minor or nonexistent. These impacts are considered to be negligible.

Turner and Cahoon (1987) found that OCS traffic comprises a relatively small percentage (~9%) of the total commercial traffic using navigation channels. The average contribution of a WPA proposed action to the total OCS-related vessel traffic in navigation canals is expected to be small (2%). Erosion of coastal barrier beaches and associated dunes from vessel traffic associated with a WPA 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, 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 appropriately reducing the depth of the channel. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies. Effects on coastal barrier beaches and associated dunes associated with dredging from a WPA proposed action are expected to be restricted to minor and localized areas downdrift of the channel. A gas processing plant associated with a WPA proposed action would not be expected to be constructed on barrier beaches. Effects on coastal barrier beaches and associated dunes associated with continued use of existing OCS gas processing plants and pipeline infrastructure from a WPA proposed action are expected to be restricted to minor and very localized areas downdrift of the facility or landfall site.

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 WPA proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 pipeline landfalls projected in support of a WPA proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods and regulations. New gas processing plants would not be expected to be constructed on barrier beaches. A WPA proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and localized impacts on adjacent barrier beaches downdrift 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. 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. Because these impacts occur whether a WPA proposed action is implemented or not, a proposed action would account for a small percentage of these impacts.

In conclusion, a WPA 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. A WPA proposed action may extend the life and presence of facilities in eroding areas through modifications to channel training structures (jetties) and the utilization of beach restoration and nourishment techniques combined with dune restoration. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas. It is also highly unlikely that oil from the DWH event would be introduced by vessel traffic or channel maintenance due to the distance of the DWH event from the Texas coast and decontamination procedures in place for boats that were inside of the containment booms. In addition, if encountered, the remnant oil is expected to be nontoxic due to natural weathering, microbial breakdown and post-spill dispersant treatment.

4.1.1.3.3. Impacts of Accidental Events

Background/Introduction

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. 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 4.1.1.4.3**). Impacts to biological, recreational, and archaeological resources associated with beach and dune environments are described in the impact analysis sections for those specific resources.

The passage of two powerful hurricanes in 2008 (Gustav and Ike) has resulted in changes in barrier island topography and the lowering of beach and dune ridge elevations. These changes potentially increase the probability for beach oiling farther up the beach in some locations along the Texas coast. The 2008 hurricane season was devastating to both the Louisiana and east Texas coasts. Hurricanes Gustav and Ike impacted the coastal areas of Louisiana and Texas within a 2-week period. The Texas coast was spared major damage from Hurricane Gustav but it took the brunt of Hurricane Ike. The most extensive damage occurred on the Bolivar Peninsula, Texas, as a result of the overtopping of dunes and breeching beach ridges, resulting in reduced dune height and in some cases the removal of the dunes completely. Dune-height changes exceeding 1 m (3 ft) were observed more than 60 km (32 mi) to the east and 40 km (25 mi) to the west of Hurricane Ike's landfall. In Galveston, Texas, the seawall (considered to be the dune crest) elevation change was roughly 30 cm (12 in), which is consistent with the previously determined vertical offset (Doran et al., 2009).

The DWH event oiled approximately 1,000 mi (1,609 km) of shoreline, including barrier islands in the CPA due to the close proximity of the spill to CPA and EPA Gulf Coasts. Except for a small amount of tarballs reported along Bolívar Peninsula, Texas, as reported by Coast Guard Commander Marcus Wooding (Lozano, 2010), there are no other public reports of oiled beaches in Texas. Although only a few tarballs related to the DWH event reached the WPA, the DWH event may shed some light on potential exposures in the unlikely event of a future catastrophic event. Should a catastrophic spill such as the one associated with the DWH event occur in the proximity of the WPA, the implications of such a spill are discussed in **Appendix B**.

Coastal spills in offshore coastal waters or in the vicinity of Gulf tidal inlets present a greater potential risk to barrier beaches because of their close proximity. Inland spills that occur away from Gulf tidal inlets are generally not expected to significantly impact barrier beaches and dunes.

Proposed Action Analysis

Barrier islands and beaches adjacent to the WPA are restricted to the coastal waters of Texas and western Louisiana. The wetlands located landward of the barrier beaches and dune systems 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. Although the impact can occur over all coastal regions, the impact has the highest probability of occurring in Matagorda County in Texas where the WPA oil is handled. In the waters 0-3 nmi (0-3.5 mi; 0-5.6 km) off of the Texas coast, there were a total of 250 spills reported from 1996-2009 or about 20 spills <1,000 bbl/yr (**Table 3-21**). **Chapter 3.2.1.7.1** shows that 96 percent of Federal oil and gas activity spills are <1 bbl and 4 percent of Federal oil and gas activity spills are 1-999 bbl, with an average size of 77 bbl. Although this is a rough approximation, 20 spills <1,000 bbl/year are estimated to result from State or Federal oil and gas activity into the waters 0-3 nmi (0-3.5 mi; 0-5.6 km) off of Texas annually (**Table 3-21**).

The incremental increase in oil production from a WPA proposed lease sale is not expected to result in an overall increase in the number of oil spills ≥1,000 bbl likely to occur as a result of a WPA proposed action. Activity that would result from the addition of a WPA 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 occurring and contacting environmental resources (including barrier islands) can be found in **Chapters 3.2.1.6.6 and 3.2.1.7.2**. One parish in Louisiana and nine counties in Texas have a chance of a spill ≥1,000 bbl occurring and contacting their shores based on a WPA proposed action. For these parishes/counties, the probability of an OCS offshore spill ≥1,000 bbl ranges from <0.5 to 3 percent. Matagorda County in Texas has the highest probability at 1-3 percent (**Figure 3-15**).

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 (1-3) offshore spills of 50-1,000 bbl are estimated to occur as a result of a WPA proposed action (**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.

Should a spill contact a barrier beach, oiling is expected to be light. It should be noted that, because of changes of topography from storm events, oiling can occur farther up the beach. Sand removal during cleanup activities should be minimized, and invasive techniques required for deep sediment oiling should not be required. No significant impacts on the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a WPA proposed action.

Oil-Spill Impacts

The level of impacts from oil spills depends on many factors, including the type, rate, and volume of oil spilled; weather and oceanographic conditions at the time of the spill; geographic location; season; and oil-spill-response and cleanup preparedness. These parameters can determine the quantity of oil that is dispersed in the water column and the actual amount, concentration, toxicity, and composition of the oil at the time of the shoreline contact. All of those factors determine if an oil spill will cause heavy long-lasting biological damage, comparatively little damage, or no damage.

A study in Texas showed that oil disposal on sand and vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the local plant community (Webb, 1988). This study had controlled, comparative lab studies and manmade dunes constructed with "oiled sands" (from crude oil spill off the Texas coast) to determine the effects of oil contamination on beach and dune vegetation. These "oiled sand" dunes were constructed with slopes comparable (60%) to those of natural dunes. Various types of dune vegetation (*Spartina patens, Panicum amarum, Rubus trivialis, Ambrosia psillostachya,* etc.) were tested to ascertain survivability and biomass production in the "oiled sands" and were compared with natural dunes. *Spartina* and *Panicum* species were the primary focus of the laboratory studies. The study indicated that *S. patens* had a 50-percent survival rate in "oiled sands" and a 38-percent survival rate in oil-free sands in the laboratory studies. *P. amarum* had a 31-percent survival rate in both oiled and oil-free conditions. Both *S. patens* and *P. amarum* were transplanted to oil-contaminated and oil-free dunes. Survival of dune transplants was better for both species tested in the oil-contaminated dune (81%) than the oil-free (62%) dune. Not only did the vegetation survive but it also produced favorable biomass similar to natural conditions. Both the dune and laboratory experiments indicated that the oil did not prevent plant establishment. It was concluded that common dune plants can colonize or can be transplanted successfully into oil-contaminated sands. The researchers did note that oil reaching the beach would probably have undergone weathering from photo-oxidation, volatilization, and biodegradation. However, tests results of the oiled sands indicated that, while lighter toxic alkenes and cyclic alkenes were absent in the "oiled sands," 21 percent of the crude oil was water-insoluble PAH's. Analysis of the weathered crude oil did not indicate a high percentage of PAH's. It is concluded that the weathering process removed most of the toxic compounds (Webb, 1988).

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 are location (proximity of spill in distance from landfall) and weather. If there is sufficient distance and proper weather conditions between the spill and landfall, the spill can be dispersed and thinned out and optimal conditions are set for biodegradation, volatilization, and photo-oxidation of the more toxic components of the oil.

Oil-spill cleanup operations can affect barrier beach stability. If large quantities of sand are removed during spill-cleanup operations, a new beach profile and sand configuration would be established in response to the reduced sand supply and volume. The net result of these changes could be accelerated shoreline erosion rates, especially in a sand-starved and eroding-barrier setting such as found along the Louisiana Gulf Coast. To address these possible impacts, the Gulf Coast States have established policies to limit sand removal by cleanup operations.

Most inshore spills resulting from a WPA proposed action would occur from barge, pipeline, and storage tank accidents involving transfer operations, leaks, and pipeline breaks. These are far from barrier beaches. When transporting cargoes to terminals, oil barges make extensive use of interior waterways. These interior waterways are remote from barrier beaches, so most inshore spills are assumed to have no contact with barrier beaches or dunes. For a barge or pipeline accident in State or Federal offshore waters to affect a barrier beach, the accident would need to occur on a barrier beach or dune or near a tidal inlet. Inshore pipelines or barge accidents are assumed to result in spilled oil contacting the inland shores of a barrier island, with unlikely adverse impacts to barrier beaches or dunes.

Oil that makes it to the beach can be liquid, weathered oil, an oil and water mixture, or tarballs. Oil is generally deposited on beaches in lines defined by wave action at the time of landfall. Initially, components of oil on the beach will evaporate more quickly under warmer conditions. Under high tide and storm conditions, oil may return to the Gulf and be carried higher onto the beach by future tidal events. Oil that remains on the beach will thicken as its volatile components are lost. Thickened oil may form tarballs or aggregations that incorporate sand, shell, and other materials into its mass. Tar may be buried to varying depths under the sand. On warm days, both exposed and buried tarballs may liquefy and ooze and can serve to expand the size of a mass as it incorporates beach materials.

Oil on the beach may be cleaned up manually, mechanically, or both methods. Removal of sand during cleanup is expected to be minimized to avoid significantly reducing sand volumes. Some oil will likely remain on the beach at varying depths and may persist for several years as it slowly biodegrades and volatilizes (OSAT-2, 2011).

Summary and Conclusion

Because of the proximity of inshore spills to barrier islands and beaches, these inshore spills pose the greatest threat because of its concentration and lack of weathering by the time it hits the shore and because dispersants are not an effective means of spill response. 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 less 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. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Although the most current information did reveal that some of the barrier islands had experienced storm-induced reductions in beach shoreline elevations and erosion, the significance of this loss of protection is small in comparison with other continuing natural forces such as subsidence, sea level rise, and the continued reduction in sediment supply, that aid in the deterioration of these islands (USDOC, NMFS, 2007a). Therefore, the currently available information suggests that impacts on barrier islands and beaches from accidental impacts associated with a WPA proposed action would be minimal. However, the long-term effects of the berm construction on Chandeleur Island cannot be evaluated at this time because of 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 WPA proposed action. A WPA proposed action would not pose a significant increase in risk to barrier island or beach resources.

4.1.1.3.4. Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a WPA 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.

In addition to the above-mentioned factors, the largest continuous oil spill to date (the DWH event) occurred in the Gulf of Mexico on April 20, 2010, spreading 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. This historical spill occurred in neighboring Federal waters approximately 60 mi (97 km) off the coast of Louisiana; however, due to currents and winds, it had negligible physical effects on the Texas coast and coastal habitats. The spill is mentioned here since support vessels and oil transports may have traveled through the spill zone to gain access to Texas ports and refineries.

River Channelization and Beach Protection

The Texas coast has experienced a natural decrease in sediment supply as a result of climatic changes (e.g., diminished rainfall) that have occurred during the past few thousand years and dam construction, both of which have resulted in the loss of sediment and sediment transport (Morton, 1982). As reported in Gibeaut et al. (2008), engineering modifications to the Brazos and Colorado Rivers in the form of river diversions and dredging allowed more sediment to reach the Texas coast. The cumulative effect of these actions have supplied sand and caused shoreline advance in the downdrift (southwest) direction. The jetties at the Matagorda Ship Channel have caused dramatic shoreline advance on the updrift (northeast) side but shoreline retreat on the downdrift (southwest) side. This land loss is related to the downdrift effect of the channel's jetties and the overall natural state of erosion along the coast. This shoreline will continue to retreat in the future until it intersects the hardened seawall and revetted shoreline at Sergeant Beach. This altered shoreline will reduce the sand supply, resulting in enhanced shoreline retreat. The seawall construction along eroding stretches of islands has reduced the amount of sediment introduced into the littoral system by erosion.

The Texas Chenier Plain was created by reworked sediments from the Mississippi River depositions, which are now decreased by beach and channel stabilization and flood protection works. Reductions in sediment supply along the Texas coast will continue to have a significant adverse impact on barrier landforms there. Subsidence, erosion, and dredging of inland coastal areas and the concurrent expansion of tidal influences continue to increase tidal prisms around the Gulf. Over the course of geological history since the peak of the last ice age 18,000 years ago, the barrier islands have migrated toward the present coast. The Gulf-facing coasts of the barrier islands have been eroded by the steady rise in sea level. Historically, as the Gulf's coast retreated, the landward side of the islands has extended and has been built up by sand deposits from over wash during storms. Today that process has ceased in the case of many of the Texan barrier islands. The beaches of the islands are also being eroded by wave action increased by sea walls, jetties, and vegetated dunes. The vegetated dunes prevent some degree of sediment transport to the back side of the dune and increase the potential for erosion due to wash back on the dune face. The islands are getting narrower through both natural processes and the influence of mankind.

Human disturbance to the fragile natural environment has hastened the erosion of these natural storm barriers (Jones and Wells, 1987). 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 will cause adverse impacts to barrier beaches and dunes. Efforts to stabilize the Gulf shoreline have adversely impacted barrier landscapes in Louisiana and Texas. Large numbers and varieties of stabilization techniques, such as groins, jetties, and seawalls, as well as artificially-maintained channels and jetties, 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, which accelerates erosion there, and by increasing or redirecting the erosional energy of waves (Morton, 1982). Over the last 20 years, dune and beach stabilization have been better accomplished by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings.

Natural Processes

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 in an attempt to control catastrophic floods and change the natural environment to better accommodate navigation on waterways used to support OCS and non-OCS seaborne 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. Both the western edge of the Louisiana coast and the eastern Texas coast in the WPA received major damage as a result of Hurricanes Katrina, Rita, Gustav, and especially Ike. Texas beaches and barrier islands received the greatest impact from Hurricane Ike. Texas barrier islands and mainland beaches lost elevation and vegetative cover as a result of the erosion accompanying the storm-driven debris and sheer tidal surge. The removal of vegetative cover and scour scars from storm surges also provides an avenue for additional erosion as a result of inlet formations and tidal rivulets. These modifications to island topography 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 on islands. This loss of elevation, combined with the effect of shoreline retreat and removal of vegetation, will continue to allow the expansion of the over wash zone. This reduction in island elevation also results in less frontline protection to valuable marshes within major wildlife refuges like the McFaddin Complex (USDOC, NMFS, 2007a). The reduced elevation of the barrier island and mainland also make urban and industrial areas protected by these marshes and beaches at a higher risk of damage. The reduction in storm protection once provided by barrier islands will result in further conversion of fresh marsh to either open water or salt marsh.

Pre- and post-storm studies by University of Texas noted that underwater sand and gravel ridges near the Bolivar inlet were reduced in size and moved landward by Hurricane Katrina and again by Hurricane Gustav (Perkins, 2010). Remnants of these ridges are now located in or adjacent to the Bolivar Inlet, which decreases the depth of the inlet and will require maintenance dredging as a result. The Bolivar Inlet channel was not only reduced in depth but also widened by the erosive forces of the storm surge. This inlet was then eroded to a greater width by the storm surge from Hurricane Ike. Because of these changes and the minimized elevation of underwater shoals, there is a change in the hydrology that once provided the current configuration responsible for sculpting and stabilizing the portions of both Galveston Island and the Bolivar Peninsula, which were closest to the Bolivar Inlet. Due to hurricane-induced changes in hydrology, the cumulative effect of additional storms has the potential to further erode barrier islands unless restoration methods are implemented.

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 WPA proposed action are expected to be restricted to temporary and localized disturbances. The estimated 0-1 pipeline landfall projected in support of a WPA proposed action is not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods such as directional boring. The estimated 0-1 gas processing plants would not be expected to be constructed on barrier beaches. The use of some existing facilities in support of a WPA proposed action and subsequent WPA proposed lease sales 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. They may also cause the accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts will last as long as the interruption of the sediment drift continues, which may 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 governmental and landowner requirements. All materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Existing inland facilities may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and could contribute to erosion there. A WPA 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 causes minor and localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. These impacts would occur whether a WPA proposed action is implemented or not. A WPA 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. However, due to the effects of recent hurricanes on hydrologic features (e.g., the elimination of underwater sand and gravel ridges noted above), the potential for future erosion of barrier islands is expected to continue. The displacement of these underwater features can potentially increase dredging requirements in the inlets around the Bolivar Peninsula, which in turn leads to increased velocities in the inlets that may increase erosive currents near the barrier islands. The severity of storm effects on these already degraded islands and beaches depends on the frequency and intensity of future storms, and the timely implementation of planned and proposed coastal restoration projects. In addition, inlet maintenance would continue as a result of the cumulative effect of subsequent hurricanes.

A WPA proposed action may extend the life and presence of facilities in eroding areas, which would 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.

While vessel traffic to support increased well numbers may also increase over the life of the estimated 40-year period of OCS activities, it is doubtful that an overall increase will continue since some older wells will be coming out of service as new wells come into service. 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. The entire proposed 5-Year Program accounts for only 9 percent of the commercial ship traffic (**Tables 3-4 and 3-14**). A WPA proposed action is now estimated to account for 2 percent of the service-vessel traffic of the propsed 5-Year Program (**Tables 3-2 and 3-4**). Further details concerning vessel traffic can be found in **Chapter 3.1.1.8.4**.

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.

Most spills occurring in offshore coastal waters are assumed to proportionally weather and dissipate before hitting the Texas coast, as described in **Table 3-23**. Dispersants are not expected to be used in coastal waters. No calculation has been made to estimate how much oil might be deposited on a beach if dispersants are not used. Unfavorable winds and currents could further diminish the volume of oil that might contact a beach. A persistent, northwesterly wind might preclude contact. Tide levels could reach or exceed the elevations of sand dune vegetation on barrier beaches depending on the particular coastal setting and the elevation of the vegetation. The strong winds 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. The probabilities of spill occurrence and contact to barrier beaches and sand-dune vegetation are considered low. Hence, contact of sand-dune vegetation by spilled oil is not expected to occur. The mixing would reduce the oil concentrations contacting the beach and vegetation, greatly reducing impacts on vegetation.

In the case of Texas, the barrier islands are close to the mainland and under normal conditions have a greater potential of being affected by inland and nearshore spills than offshore spills. Due to the distant proximity of these islands and beaches from producing offshore wells, the DWH event had little detectable effect on the Texas beaches and barriers. Weather, sea conditions, currents, and timely response efforts to this large-scale spill greatly reduced the risk of oil reaching the shores of Texas. However, the reduction in slope on the beach face, loss of dune elevation, and development of scour inlets resulting from past hurricane activity contribute to future vulnerability of the once-protected coastal inland habitats from oil spills. The barrier and mainland beaches will continue to be susceptible to spills associated vessel collisions, pipeline breaks, and refinery accidents near or at transfer facilities by the ports of Houston and Beaumont. Hurricane Ike resulted in numerous oil spills along the Texas coast. The largest effects were along the Bolivar Peninsula where the storm came ashore. There were also over 202 ha (500 ac) of Federal refuges affected by Ike-related oil spills. Other refuges such as Bessie Heights Marsh and Murphree Wildlife Management Area had from 486 to 809 ha (1,200 to 2,000 ac) affected by oil sheens and some physical oilings (Texas Parks and Wildlife Department, 2008). Future spills that would affect these areas are possible as refinery and offshore production facilities and pipelines continue to age and become more vulnerable to storm and hurricane damage. The average age of production facilities and pipelines in the Gulf is approximately 20 years, with some platforms still in production after 60 years (Casselman, 2010). Most of the hurricane-related spills resulted from storm damage to older pipelines and other aging infrastructure. Past studies have shown that there is a direct relationship between older offshore production facilities and the potential for accidents and spills (Pulsipher et al., 1998). It is expected that, in the future, more of these facilities will be taken out of production or be replaced as new infrastructure is brought on line. With the placement of new infrastructure, combined with the continual updating of safety regulations and programs, it is expected future spills would be greatly reduced.

The results of an investigation on the effects of the disposal of oiled sand on dune vegetation in Texas showed no deleterious impacts on the existing vegetation or on the 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.

Most of the Texas coast is comprised of sandy beaches with little vegetation directly on the beach head, and the more vulnerable wetland vegetation is located behind the dune or beach systems where they are less likely to come in contact with spilled oil from the OCS. Beach cleanup techniques involving heavy machinery can drive oil farther into the sediment; however, the new machinery allows the sand to be sifted in place and returned to the beach after the oil is removed. 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. During hot, sunny days, tarballs buried near the surface of the beach sand may liquefy and cause a seep to the sand surface. The long-term stressors, including physical effects and chemical toxicity of hydrocarbons, may lead to decreased primary production, plant dieback, and hence further erosion (Ko and Day, 2004a).

This analysis assumes that Texas would require the responsible party to clean the beach without removing significant volumes of sand or to replace the sand removed. Therefore, 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 clean up.

Recreational Use and Tourism

Most barrier beaches in the WPA are accessible to people for encouraged recreational use because of public road access. The Texas Open Beaches Act of 1959 guarantees the public’s right to unimpeded use of the State’s beaches. It also provides for public acquisition of private beachfront property. 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. Judd et al. (1988) documented that as much as 18 percent of the total dune area along parts of South Padre Island, Texas, had experienced damage from vehicular traffic. Recreational vehicles and even hikers have been problems where road access is available and the beach is wide enough to support vehicle use. Areas without road access will have limited impacts by recreational vehicles. Hurricane Ike heavily impacted both the highly developed beaches along the Bolivar Peninsula and recreational areas associated with State and Federal wildlife management areas and refuges. Currently, these areas are being restored through programs associated with the Texas Coastal Erosion Planning and Response Act. These actions are being coordinated with State and Federal resource agencies to assure redevelopment is compatible with the environmental functions of these sensitive beaches and wetlands. Dune restoration and installation projects along the hard-hit McFaddin Beach are underway with beach nourishment projects along South Padre and Rollover islands (Texas General Land Office, 2007). These and other projects planned for shoreline protection and wetland restoration under the Texas Coastal Erosion Planning and Response Act and the FWS Coastal Impact Assistance Program are expected to continue to mitigate the loss of these sensitive environments in the future. A WPA proposed action would not provide any additional access that would result in increased negative cumulative impact to the barrier beaches and dunes.

Summary and Conclusion

River channelization, sediment deprivation, tropical and extra-tropical storm activity, sea-level rise, and rapid submergence have resulted in severe, rapid erosion of most of the barrier and shoreline landforms along the Louisiana coast. The Texas coast has experienced landloss because of a decrease in the volume of sediment delivered to the coast because of channelization and damming of coastal rivers, a natural decrease in sediment supply as a result of climatic changes during the past several thousand years, and subsidence along the coast. Storm-induced changes in hydrology have, in some cases, changed the current regime responsible for stabilizing the barrier islands. Beach stabilization projects 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 Texas coast should not result in long-term alteration of landforms if the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes. Barrier beaches in the region around Galveston have the greatest risks of sustaining impacts from oil-spill landfalls because of the high concentrations of oil production near that coast. However, the majority of inshore spills are assumed to be small in scale (historical data indicate they average 77 bbl; **Chapter 3.2.1.7.1**) and short in duration; therefore, impacts would be minor. Oil from most offshore spills is expected to be weathered and 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, particularly if carried onto dunes by hurricanes.

Under the cumulative scenario, 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, and that had been placed on barrier islands using older techniques that left canals or shore protection structures, have caused and would continue to cause barrier beaches to narrow and breach.

Recreational use of many barrier beaches in the WPA is intense due to their accessibility by road. These activities can cause changes to the beach landscapes. There are ongoing restoration efforts to minimize damages to beaches from both natural and human impacts.

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 severe local impacts and accelerate the 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 (Texas), and county governments have made efforts through the Texas Coastal Erosion Planning and Response Act program and Coastal Management Plan programs to restore or protect the sensitive and vulnerable barrier islands and mainland beaches.

A WPA 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 WPA proposed action may extend the life and presence of facilities in eroding areas, which would accelerate erosion in those areas. A WPA proposed action is not expected to increase the probabilities of oil spills beyond the current estimates. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas. Thus, the incremental contribution of a WPA proposed action to the cumulative impacts on coastal barrier beaches and associated dunes is expected to be small.

4.1.1.4. Wetlands

The full analyses of the potential impacts of routine activities and accidental events associated with a WPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this section. A brief summary of potential impacts follows. Effects to coastal wetlands from the primary impact-producing activities associated with a WPA proposed action are expected to be low. The primary impact-producing activities associated with routine activities for a WPA proposed action that could affect wetlands include pipeline emplacement, construction and maintenance, navigational channel use (vessel traffic) and maintenance, disposal of OCS-related wastes, and use and construction of support infrastructure in these coastal areas. Vessel traffic associated with a WPA 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. Wetland loss is also expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates. The incremental contribution of a WPA proposed action to the cumulative impacts on coastal wetlands is expected to be very small.

Routine activities in the WPA 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 WPA proposed action's impacts to the cumulative impacts to wetlands is small and expected to be negligible.

The wetlands in the WPA have been affected either directly or indirectly by the successive large-scale hurricanes (Katrina, Rita, Gustav, and Ike) over the past 6 years as well as marginally subjected to the influence of the largest oil spill in U.S. history (DWH event). Hurricane Alex only marginally affected Texas with massive amounts of rain. While still unsubstantiated, accounts have noted that the storm may have been responsible for pushing a few isolated tarballs from the DWH spill site to the beaches of the Bolivar Peninsula. Analysis of these tarballs has not been completed; therefore, at this time the source of these tarballs is not known. There is speculation that these tarballs may have been brought in by ship traffic (Lozano, 2010). Based on known information concerning hurricane effects on the Texas coast and the observed potential of oil exposure from the DWH event on the Bolivar Peninsula, the description of these resources will include pre- and post-storm conditions as well as pre- and post- oil-spill conditions.

4.1.1.4.1. Description of the Affected Environment

According to the U.S. Dept. of the Interior (Dahl, 1990; Henfer et al., 1994), during the mid-1980's, 4.4 percent of Texas (3,083,860 ha) (Henfer et al., 1994) was considered wetlands. One of the important functions of coastal marshes and barrier islands is as a frontline of defense against storm surge.

High organic productivity and efficient nutrient recycling are characteristic of coastal wetlands. They 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. Freshwater-marsh environments generally contain a much higher diversity of plants and animals than do those of saline marshes.

Wetland habitats found along the Texas Gulf Coast include fresh, intermediate, brackish, and saline marshes; mud and sand flats; and forested wetlands of mangrove swamps, cypress-tupelo swamps, coastal flatwoods, and bottomland hardwoods. Coastal wetland habitats occur as bands around waterways and as broad expanses. Saline and brackish habitats support sharply delineated, segregated stands of single plant species. Fresh and very low salinity environments support more diverse and mixed communities of plants. The plant species that occur in greatest abundance vary greatly around the Gulf. For those reasons, interested readers are referred to ecological characterization and inventory studies conducted by the FWS, in cooperation with other agencies; the Texas Bureau of Economic Geology; and other researchers (Gosselink et al., 1979; Smith, 1984; Fisher et al., 1972 and 1973; Brown et al., 1976 and 1977; Stout et al., 1981; Texas Parks and Wildlife, 2003).

Along the Texas coast estuarine or tidal fringe wetlands can be vegetated (marshes) or unvegetated (mud and sand flats) and are found between the open saltwater of the bays or Gulf and the uplands of the coastal plain and barrier islands. These wetlands may occur in small strips just 10-20 ft (3-6 m) wide or may be several miles wide and occupy thousands of acres. Marshes are almost always in protected areas along bay shorelines or on the bay sides of barrier islands and peninsulas (Texas Parks and Wildlife, 2003). Salt marshes are flooded by tides and their salinity and plant communities depend upon how much fresh water is delivered to the wetlands by the rivers that flow into the bays. The high marsh is only irregularly flooded by tides and may go for extended periods without flooding. The low marsh, however, is subject to regular flooding, at least once a day. Cordgrasses of the *Spartina* genus are the most prominent salt-marsh vegetation. Flooding frequency, duration, and the salinity level are the most important variables that control the kinds of plants that occur in the salt marsh. In the high marsh, saltmeadow cordgrass might be the most common grass, whereas in the lower marsh, saltmarsh cordgrass is more common. Additional vegetation includes saltgrass, saltmarsh bulrush, and needlegrass rush among others. Since the mid-1950's, the area of salt and brackish marshes on the Texas coast has decreased by more than 8 percent; a net loss of more than 31,000 ac (12,545 ha) (Texas Parks and Wildlife, 2003).

Texas Barrier Islands and Tamaulipas Coastal Wetlands

Landward of the barrier beaches of Texas, estuarine marshes largely occur as continuous and discontinuous bands around bays, lagoons, and river deltas. The troughs created between the dune systems on the barrier islands receive freshwater runoff from the adjacent dunes as well as elevated fresh groundwater that floats on the top of the saltwater as sea level rises (Texas Parks and Wildlife, 2003). Freshwater wetlands are found in these interdunal swales and on larger interior wind-eroded flats on the barrier islands that line the Texas coast. The wetland plants found in these interdunal fresh areas are similar to those found in other freshwater marshes, but they may include some brackish-water species due to elevated soil salinity in some areas. Typical species include saltmeadow cordgrass, southern cattail, bulrushes, coastal water-hyssop, coastal plain pennywort, spikerushes, flatsedges, sedges, burhead, marsh fimbry, white-topped sedge, frogfruit, coffee bean, seashore paspalum, bushy bluestem, and other grasses.

Tidally influenced wetlands on the bay margins of the islands are included with the Tidal Fringe wetlands. Broad expanses of emergent wetland vegetation do not commonly occur south of Baffin Bay because of the arid climate and hypersaline waters. In the vicinity of southern Padre Island, marshes are minimal and unstable compared with the more northern Gulf. In Tamaulipas, Mexico, marshes behind the barrier islands are even less abundant than seen in the vicinity of Padre Island. Dominant salt-marsh plants in southern regions include more salt-tolerant species such as turtleweed (*Batis maritime)* and glasswort (*Salicornia* sp.).

Brackish marshes occur in less saline, inland areas and are divided into frequently and infrequently flooded marshes. Infrequently flooded marshes contain an assemblage of plants that are much more tolerant of dry conditions. Freshwater marshes in Texas occur inland above tidally delivered saline waters, in association with streams, lakes, and catchments. Broken bands of black mangroves (*Avicennia germinans*) also occur in this area (Brown et al., 1977; White et al., 1986).

Wind-tidal flats of mud and sand are mostly found around shallow bay margins and in association with shoals. As one goes farther south from Corpus Christi and into Tamaulipas, flats increasingly replace lagoonal and bay marshes. The Laguna Madre of Texas is divided into northern and southern parts by the wind-tidal flats of the Land-Cut Area, just south of Baffin Bay.

Inland beaches of sand and shells are found along the shores of bays, lagoons, and tidal streams. The structure of these beaches is similar to, but much narrower and smaller in scale than, barrier beaches. Compared with the sand beaches, shell features are typically stacked to higher elevations by storm waves and are generally more stable.

Few freshwater swamps and bottomland hardwoods occur in the general vicinity of OCS-related service bases and navigation channels of the Texas barrier island area. In the southern third of this area, they are nonexistent (Brown et al., 1977; White et al., 1986).

Chenier Plain

The Chenier Plain is a unique salt marsh area on the extreme eastern edge of the Texas Gulf Coast and is part of a much larger Chenier Plain in western Louisiana. A Chenier Plain is a series of sandy or shelly ridges or "cheniers," many more than 10 ft (3 m) high, separated by clayey or silty marsh deposits. The distance from chenier to chenier may be as much as 1 or 2 mi (1.6 or 3.2 km) or more. The Texas Chenier Plain started to form about 3,000 years ago when the mouth of the Mississippi River shifted to the west, bringing an increase in sediment to southwestern Louisiana and extreme southeast Texas. These sediments built marshes out into the Gulf. During periods of low sediment input, wave action reworked the Gulf-facing sediments into ridges or cheniers, until the next pulse of sediment built marsh farther out into the Gulf again, resulting in the characteristic series of ridges (Texas Parks and Wildlife, 2003). The current portion of the Texas Chenier Plain is located between Port Bolivar, Texas, and Atchafalaya Bay in Louisiana. As the area filled in, a series of shell and sand ridges were formed parallel or oblique to the present-day Gulf Coast and were later abandoned as sea level continued to fall. Mudflats formed between the ridges when localized hydrologic and sedimentation patterns favored deposition there. This intermittent deposition isolated entrenched valleys from the Gulf, forming large lakes such as Sabine, Calcasieu, White, Grand, and others (Gosselink et al., 1979; Fisher et al., 1973). As a result, few tidal passes are found along this coast as compared with central Texas and eastern Louisiana. This reduces the tidal movement of saline waters. The mouth of the Mississippi River has shifted repeatedly during the last 3,000 years, causing alternating slow beach deposition and rapid marsh building into the Gulf. In this way, the once broad bay of the Sabine and Neches Rivers was cut off from the Gulf by the deposition of the Chenier Plain wetlands. Wetlands in the low areas between the beach ridges are estuarine salt and brackish marshes connected by tidal channels to Sabine Pass.

Because of the structure of the Chenier Plain and its beaches, salt marshes are not as widely spread there as elsewhere in the northern Gulf. Generally in this area, salt marshes front the Gulf directly and are frequently submerged by tides and storms. Hence, they are considered high-energy environments, as compared to most vegetated wetlands. Brackish and intermediate salinity marshes are dominant in estuarine areas of the Chenier Plain. They are tidal, although wind-driven tides are more influential and occasionally inundate these areas. Since salinity in this area ranges broadly, these habitats support a mix of salt and salt-tolerant freshwater plants, although marsh-hay cordgrass is generally dominant. These habitats are the most extensive and productive in coastal Louisiana.

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 often changes from season to season as a result of year-round, seed-germination schedules. Freshwater wetlands are extensive in the Chenier Plain due to the abundant rainfall and runoff, coupled with the ridge system that retains freshwater and restricts the inflow of saline waters. Tidal influences are generally minimal in these areas, although strong storms may inundate the area. Hence, detritus is not as readily exported and accumulates there, supporting additional plant growth. Freshwater marsh plants are generally more buoyant than estuarine plants. In areas where detritus collects thickly, marsh plants may form floating marshes, referred to as “flotants.” Flotants generally occur in very low-energy environments. They are held together by surrounding shorelines and a weave of slowly deteriorating plant materials and living roots.

The coastal flatwoods occur on the poorly drained flats between coastal rivers but, unlike bottomland hardwoods, they do not receive or depend on river overflow for their water supply. These flatwoods are located in areas where rainfall is captured and the soil characteristics promote slow runoff. The flatwoods wetlands stretch from the Louisiana border west to about the Houston area, and they are extensive. These forest assemblages tend to be located between rivers and streams on the upper Texas coast. The coastal flatwoods are dominated by either pine or hardwoods. Common trees of the drier pine wet flatwoods are longleaf, shortleaf, and loblolly pines. The wetter hardwood flatwoods include willow and laurel oaks, swamp chestnut oak, cherrybark oak, and sweetgum, with dwarf palmetto common in the understory. The southern extension of the Piney Woods region of East Texas once was occupied by poorly drained, longleaf pine woodlands that extended south into eastern Harris County. This community was a matrix of beakrushes, sedges, and grasses with scattered longleaf pines and was maintained by frequent burning. As fire was suppressed by humans, trees and shrubs like black tupelo, sweetgum, wax-myrtle, and yaupon increased. Loblolly pine is now dominant and has been favored by the commercial timber industry. The hardwood flatwoods occur on the coastal prairies and marshes region of the upper coast. The suppression of fire may have favored hardwoods in some areas that were longleaf pine savanna.

As previously noted, the existing coastal landscape has now been altered by a series of powerful hurricanes that have changed the current condition and sometimes functions of the wetland resources along the Texas and Louisiana coasts. Hurricane Rita made landfall in September 2005 along the Texas/ Louisiana coast. Most of the wetlands along the Texas coast are associated with the national wildlife refuges and State wildlife management areas, such as Texas Point National Wildlife Refuge, McFaddin

National Wildlife Refuge, Sea Rim State Park, and J.D. Murphree State Wildlife Management Area. These areas comprise the McFaddin Complex and contain over 60,000 ac (24,280 ha) of coastal marsh (fresh, intermediate, and brackish) coastal prairie (nonsaline and saline), coastal woodlands, and beach/ridge habitat in Jefferson and Chambers Counties in southeast Texas. The ridge/dune system that was the main buffer between the Gulf and the wetlands has been significantly lowered by the overwash of the past hurricanes. While a remnant dune/beach system still exists post-Hurricane Rita, much has been lost through erosion and shoreline retreat, leaving only a low-lying washover terrace. Loss of the existing beach dunes and the lowering of beach ridge elevations along the Gulf shoreline of the McFaddin Complex from Hurricane Rita imperils approximately 30,000 ac (12,140 ha) of nationally significant wetlands due to the increasing frequency of saltwater inundation from the Gulf of Mexico. Ongoing shoreline retreat along the Gulf of Mexico, which was exacerbated by Hurricane Rita, is resulting in a rapid loss of valuable coastal habitats, including emergent estuarine marshes and coastal prairies.

In summary, the national wildlife refuges in southeast Texas suffered wetland habitat loss, primarily as a result of wave erosion, during Hurricane Rita. Impacts to three Federal refuges were estimated to include direct marsh loss of more than 75 ac (33 ha), approximately 15,000 ac (6,070 ha) of marsh under increased threat by future storms, and erosion losses along 20 mi (32 km) of shoreline (USDOI, MMS, 2007f). Following Hurricanes Katrina and Rita, two additional hurricanes (Gustav and Ike) made landfall on the Gulf Coast. While Louisiana received most of the damage from Hurricane Gustav, the Texas coast endured the brunt of Hurricane Ike, which made landfall slightly east of Galveston. The resulting 13- to 15-ft (4- to 5-m) storm surges washed over the elevated western coastline of Texas from High Island westward across the Bolivar Peninsula to the west side of Galveston Island. The storm surge basically removed the dune systems and significantly lowered the beach elevations along this portion of the Texas coast. The erosion and washover associated with Hurricane Ike's tidal surge breeched beach ridges, opening the inland freshwater ponds and their associated wetlands to the sea.

As a result of the four successive storms, the Louisiana and Texas coasts have lost protective elevations, barrier islands, and wetlands, and they now have the potential for transitioning to a less productive salt-marsh system in areas where fresh-marsh systems once existed. State and Federal Governments are currently implementing coastal restoration projects, including freshwater and sediment diversions, beach restorations, marsh building, and restoration through several programs such as CWPPRA and CIAP.

The Laguna Madre

The Laguna Madre of Texas is divided into northern and southern parts by the wind-tidal flats of the Land-Cut Area, just south of Baffin Bay. The Intracoastal Waterway is dredged through this area, as are a series of well access channels. Dredging has caused topographic and vegetative changes among the flats of Laguna Madre. The Laguna Madre is the very salty lagoon that supports the estuarine wetlands of the lower Texas coast. The lower coast has extensive estuarine wetlands, but the area is basically very dry and is not supportive of the lush emergent marshes of the humid upper coast. Saltwort, glassworts, saltgrass, keygrass, seapurslane, sea-oxeye, and a few other plants dominate the limited emergent salt marshes fringing the Laguna. Saltmarsh cordgrass is only a minor component of lower coast salt marshes.

Fringing the Laguna Madre are broad, nearly unvegetated wind-tidal salt flats. These sandy flats are not regularly flooded by tides. They are only occasionally flooded when strong winds push shallow water from the Laguna onto the low flats. The cycle of irregular flooding and drying causes salt to build up on the surface of the flats. These salt flats are inhospitable to most vascular plants but are often covered by vast mats of blue-green algae. Frequently flooded flats usually remain moist and may have mats of blue-green algae and an area-specific assemblage of invertebrates. Infrequently flooded flats are at higher elevations where only tides that are driven by strong wind can flood them. These are better drained and much dryer. Higher tidal flats remain barren because of the occasional saltwater flooding and subsequent evaporation that raises salt concentrations in the soil. This inhibits most plant growth; some salt-marsh plants that are tolerant of dry conditions may be found there. Some higher flats are nontidal, barren fan deltas and barren channel margins along streams. The salt concentrations of these soils are often elevated also (Brown et al., 1977; White et al., 1986). These habitats may look barren, but they support rich invertebrate populations that, in turn, attract large numbers of shorebirds and wading birds.

The black mangrove is a tropical species and forms shrub wetlands in the intertidal fringe of the Laguna Madre. Four species of tropical mangroves occur around the Gulf of Mexico, but only black mangrove is found north of the Rio Grande. Mangrove wetlands can be seen along the causeway between Port Isabel and South Padre Island, and fringing South Bay, just south of the Brownsville Ship Channel near Brazos Santiago Pass. Mangroves also occur near Harbor Island in Aransas Bay near Aransas Pass (Texas Parks and Wildlife, 2003).

4.1.1.4.2. Impacts of Routine Events

Background/Introduction

This section considers impacts from routine activities associated with a WPA proposed action to coastal wetlands and marshes. The primary impact-producing activities associated with a WPA proposed action that could affect wetlands and marshes include 0-1 pipeline emplacements, possible channel maintenance and construction, disposal of OCS-related wastes, increased vessel traffic, the 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 navigation traffic and additional onshore development encouraged by increased capacities of navigation channels.

Impacts from a WPA proposed action to coastal wetlands and marshes would occur primarily in Texas. The Texas Gulf Coast is comprised of a broad range of saline, brackish, intermediate, and freshwater wetlands. These include wet prairies, forested wetlands, barrier islands, mud flats, and riparian wooded areas. Saline and brackish marshes are most widely distributed south of the Galveston Bay area, while intermediate marshes are the most extensive marsh type northeast of Galveston Bay. The most extensive wetlands along the Texas coast are located in the Strand Plain-Chenier Plain System that runs from eastern Chambers County, Texas, through Vermilion Parish, Louisiana.

In 1955, Texas had an estimated 4.1 million ac (1.7 million ha) of coastal wetlands. Of these, about 84.6 percent (1.4 million ha; 3.5 million ac) were freshwater palustrine, 15.3 percent (253,409 ha; 626,188 ac) were saltwater estuarine, and 0.1 percent (166,137 ha; 410,534 ac) were marine intertidal. There were also 1,664,698 ac (673,679 ha) of deepwater habitats consisting of rivers (23,999 ha; 59,303 ac), reservoirs (27,334 ha; 67,544 ac), and estuarine subtidal bays (622,346 ha; 1.5 million ac). However, in 1992, an estimated 1.6 million ha (3.9 million ac) of wetlands existed. The ratio of wetland habitats was similar, with 85.3 percent palustrine, 14.5 percent estuarine, and 0.1 percent marine. There was more open-water acreage, with 728,434 ha (1.8 million ac). These include rivers with 24,345 ha (60,159 ac), reservoirs with 59,636 ha (147,363 ac), and estuarine bays with 627,292 ha (1.6 million ac). Areas with the greatest wetlands concentration appeared to be in Jefferson, Liberty, and Chambers Counties. Substantial acreage also existed in Orange, Brazoria, Fort Bend, Wharton, Matagorda, Jackson, Calhoun, and Kenedy Counties (Moulton et al., 1997). Wetland concentrations in these areas did not change significantly between 1955 and 1992. Hurricanes Katrina and Rita in 2005 and Hurricane Ike in 2008 increased erosion of beaches and wetlands along the Texas coast, causing still unquantified losses in marsh.

Pipeline Emplacement

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Many OCS pipelines make landfall on Texas' barrier island and wetland shorelines. Wetlands protect pipelines from waves and ensure that the lines stay buried and in place. Existing pipelines have caused direct landloss averaging 2.5 ha/km (10 ac/mi) (Bauman and Turner, 1990). 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 pipelines canals are open to navigation. Historically, a major concern associated with pipeline construction through wetlands was disturbance caused by backfilling. Pipeline canals were backfilled with the original dredged materials. The major factors determining the success of backfilling as a means of restoration are the canal depth, dimensions, locale, soil type, dredge-operator skill, and permitting conditions (Turner et al., 1994). Generally, plugging the canal has no apparent effect on water depth or vegetation cover. There is one exception where submerged aquatic vegetation was more frequently observed behind backfilled canals with plugs than in backfilled canals without plugs. Canal length and percentage of backfill returned have the greatest effect on the recovery of vegetation (Turner et al., 1994). While investigating backfilling canals as a wetland restoration technique in coastal Louisiana, Turner et al. (1994) discovered that canals backfilled as mitigation for offsite dredging are typically shallower if they are older or in soils lower in organic matter. Vegetation recovery increases with increased canal length and percentage of material returned. In areas where soils have high organic content (e.g., deltaic plains and the Chenier Plain), backfilling does not usually fill a canal completely, which may result in conversion to an open-water habitat.

The loss of wetland habitat is difficult to determine because it depends on the pipeline emplacement technique used, amount of backfilling, time of year, and duration of construction. After pipelines are constructed and backfilled in Texas wetlands, a shallow channel is expected to remain where the canal passes through the wetland. In the coastal areas of Louisiana, some open-water areas may remain. Approximately 6 years after backfilling has occurred, productivity of vegetation in areas directly over the pipeline is expected to be reduced. For the same period of time (approximately 6 years), productivity of wetland vegetation that flanks a pipeline is expected to be reduced as much as 11 percent in Texas. Modern pipeline emplacement techniques, such as avoidance of wetlands areas and directional boring under wetlands, result in zero to negligible impacts of pipeline activities to wetlands.

The BOEM is presently conducting a study in conjunction with USGS's Biological Resource Division to investigate coastal wetland impacts from the widening of OCS-related canals rates and the effectiveness of mitigation. Prior to this study, there were no known studies addressing the effectiveness or longevity of canal-related mitigation. Also, BOEM is currently identifying and mapping onshore OCS-related pipelines in the coastal regions around the Gulf. These include pipelines in wetland habitats in Kenedy, Aransas, Calhoun, Matagorda, Brazoria, Galveston, and Orange Counties, Texas. With the OCS pipelines identified, this study will provide basic information for environmental impact assessments and for mitigation development by BOEM and other Federal agencies.

Dredging

No new navigation channels are expected to be dredged as a result of a WPA proposed action. An increase in OCS deepwater activities, which require larger service vessels for efficient operations, is expected in the long term. This may shift some deepwater support activities to shore bases associated with deeper channels. Some of the ports that have navigation channels that can presently accommodate deeper-draft vessels may expand port facilities to accommodate these deeper-draft vessels (e.g., Port of Galveston, Texas).

Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels results in additional deposits material on existing disposal banks. The effects of dredged-material disposal banks from a WPA proposed action on wetland drainage is expected to continue unchanged, except if there are some localized and minor aggravations of existing problems. For example, some 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. Maintenance dredging would also temporarily increase turbidity levels in the vicinity of the dredging and disposal of materials, which can temporarily impact emergent wetlands and submerged vegetation communities.

Two methods are generally used to dredge and transport sediments from channels to open-water sites: (1) hydraulic cutterhead suction dredge transfers sediments via connecting pipelines and (2) 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 relief features in the placement area.

Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged material (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).

Executive Order 11990 requires that material, where appropriate, from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage. Disposal of dredged material for marsh enhancement has been done only on a limited basis. 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 WPA proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Navigation Channels and Vessel Traffic

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., fresh water, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. A trip is considered the transportation from a service base to an offshore site and back, in other words a round trip. A WPA proposed action is estimated to generate a total of 64,000-75,000 service-vessel trips over 40 years (**Table 3-2**). Most navigation channels projected to be used to support a WPA proposed action are shallow and are currently used by vessels that support the OCS Program (**Chapter 3.1.2.1.8** and **Table 3-14**). Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process as evident along the Texas coast. There, heavy traffic using the Gulf Intracoastal Waterway has accelerated erosion of existing salt marsh habitat (Cox et al., 1997). 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. 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 700 km (435 mi) of these channels support OCS-related activities in the WPA. Total navigational use (OCS and non-OCS) results in about 105 ha (259 ac) of landloss each year. Wang (1987) developed a model specific to navigation channels and their influences on saltwater intrusion using Gosselink et al. (1979) surveys. It demonstrated that, under certain environmental conditions, saltwater penetrates farther inland in deep navigation channels than in shallower channels. This suggests that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how this process results in significant habitat transition from freshwater to brackish, and ultimately to salt or open-water systems.

The existing armored navigation channels (such as Port Fourchon) that are used to reach a shore base minimize or eliminate the potential for any shoreline erosion resulting from vessel traffic. In general, widening rates for navigation canals have been reduced as a result of aggressive management and the restoration of canal edges to prevent erosion. Restoration includes the construction of rock breakwaters along portions of some of these canals and the enforcement of "wake zone" speeds (Johnston et al., 2009).

The BOEM-funded USGS study, *Bank Erosion of Navigation Canals in the Western and Central Gulf of Mexico* (Thatcher et al., 2011), indicates that shoreline retreat rates along the canals were highly variable within and across unarmored portions of the navigation canals. It was noted that geology and vegetation type influenced the rate of shoreline change. In general, Thatcher et al. noted that the 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. In addition, BOEM is funding a 2-year study (Snedden, in preparation), which was designed in cooperation with the Louisiana Department of Natural Resources' Office of Coastal Management and the USGS's National Wetlands Research Center, to better understand salinity behavior as it relates to marshes adjacent to the navigation canals. Initial work began in January 2010 and is scheduled for completion in early 2012. This study will produce useful information on how our navigation canals have affected the adjacent wetlands.

In addition, as a result of the DWH event, support vessel traffic originating from Louisiana-based ports can potentially resuspend and transport oil in the sediment from CPA supply bases. However, in the event that resuspension occurs, it is expected to be localized and unlikely to reach the WPA due to the distance of the ports from the CPA facilities.

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 WPA 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. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in **Chapter 3.1.2**. All projected new facilities that are attributed to the OCS Program and a WPA proposed action would not be in wetland areas. State and Federal permitting agencies discouraged the placement of new facilities or expansion of existing facilities in wetlands. Any impacts upon wetlands from existing facilities are expected to be mitigated.

Overview of Existing Mitigation Techniques and Results

Numerous mitigation methods have been recommended and used in the field to mitigate the impacts of pipeline construction. Depending on the location, the project, and the 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 is routinely required by permitting agencies, each pipeline mitigation process is uniquely designed to minimize damages. This considers the particular setting and equipment to be installed. Of the identified mitigation techniques, there are a number of techniques that are commonly required. **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 mitigating methods are the most common applied by the permitting agencies (COE and the State in which the activity has 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, and revegetation methods.

Proposed Action Analysis

Zero to one pipeline landfalls are projected in coastal Texas in support of a WPA proposed action. Modern pipelaying techniques and mitigations, including directional drilling and wetlands avoidance, would result in zero to negligible impacts from such a project. For a WPA proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation. On average, 9 percent of traffic using OCS-related navigation channels is related to the OCS Program (**Tables 3-4 and 3-14**). Based on the numbers of service-vessel trips projected for a WPA proposed action, a proposed action is expected to contribute 2 percent of the total OCS Program usage (**Tables 3-2 and 3-4)**. Therefore, a WPA proposed action would contribute 0.1-0.2 percent to the total commercial traffic using these navigation channels (**Tables 3-2 and 3-14**). Therefore, impacts from vessel traffic related to a WPA proposed action should remain minimal. 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. State requirements are expected to prevent and correct such occurrences. No effects to coastal wetlands from disposal of OCS-related wastes associated with a WPA proposed action are expected.

Summary and Conclusion

A WPA proposed action is projected to contribute to the construction of 0-1 new onshore pipelines. Modern pipelaying techniques and mitigations would be used for such a project. These modern pipelaying techniques use selective placement and directional drilling to avoid wetlands and to reduce the reliance on trenching and for required restoration; thus, the projected impact to wetlands from pipeline emplacement is expected to be negligible. Because of permit requirements, modern techniques, and mitigation, activities associated with a WPA proposed action are expected to cause negligible to low impacts to wetlands. Secondary impacts to wetlands caused by existing pipeline and vessel traffic corridors will continue to cause landloss. Any potential impacts from a WPA proposed action would be reduced through the continued use of armored channels and modern erosion techniques.

4.1.1.4.3. Impacts of Accidental Events

Background/Introduction

A detailed description of the wetlands resource is given in **Chapter 4.1.1.4.1**, and there is a risk analysis of accidental events in **Chapter 3.2**. The main accidental impact-producing factors that would affect wetlands are oil spills.

These 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. Although the impact can occur over all coastal regions, the impact has the highest probability of occurring in Galveston and Matagorda Counties in Texas where the WPA oil is handled. An estimated 5-10 spills could occur in coastal waters from a WPA proposed action and its support operations (**Table 3-12**). Offshore oil spills are much less likely to contact these wetlands than inshore spills because these areas are generally protected by barrier islands, peninsulas, sand spits, and currents. Nine counties in Texas and one parish in Louisiana have a chance of spill contact. For these counties and parish, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching the shoreline ranges from 0.5 to 3 percent as the result of a WPA proposed action over its 40-year life. Matagorda County has the largest probability (1-3%) of contact in the WPA. Weathering, wave action, and the use of offshore dispersants would reduce the amount of oil that would reach wetland areas and would result in minimal impacts.

Proposed Action Analysis

These 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. Although the impact can occur over all coastal regions, the impact has the highest probability of occurring in Galveston and Matagorda Counties in Texas where the WPA oil is transported on shore and distributed. An estimated 5-10 spills <1,000 bbl/yr could occur in coastal waters from a WPA proposed action and its support operations. Offshore oil spills are much less likely to contact these wetlands than are inshore spills because these areas are generally protected by barrier islands, peninsulas, sand spits, and currents. Nine counties in Texas have a chance of spill contact. For these counties, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching the shoreline ranges from <0.5 to 3 percent as the result of a WPA proposed action over its 40-year life. Matagorda County has the largest probability (1-3%) of contact in the WPA (**Figure 3-9**). Weathering, wave action, and the use of offshore dispersants would reduce the amount of oil that would reach wetland areas, resulting in minimal impacts.

Primary Impacts of Oil Spills

Offshore oil spills associated with a WPA proposed action can result from platform accidents (including blowouts and well explosions), pipeline breaks, or navigation accidents. These spills are much less likely to have a deleterious effect on vegetated coastal wetlands or seagrasses than inshore spills, except with a rare catastrophic spill such as the one associated with the DWH event. The potential effects of these catastrophic spills are discussed in **Appendix B**. Due to the distance of a WPA proposed action to wetlands, coupled with the geology of the Texas coast, the potential for massive oiling of wetland shorelines would be less likely in the WPA than in the CPA. The toxicity of the spilled oil is greatly reduced or eliminated by weathering, wave action, and the use of dispersants (if used to contain the spill in the offshore environment). However, the level of the natural protection once afforded by barrier islands has been reduced by the passing of a successive series of hurricanes between 2005 (Katrina, Rita, and Wilma) and 2008 (Gustav and Ike); therefore, there is an increased potential for oil to reach inland locations. While there are concerns that offshore spills may contribute to wetland damage, due to the distance of these production facilities offshore, the possibility of toxic oil reaching the coastal wetlands is low.

Coastal oil spills can result from storage, barge, or pipeline accidents. Most of these occur as a result of transfer operations. Many of the coastal spills occur inland. The most likely locations of coastal spills are at pipeline terminals and other shore bases. The greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. Coastal or inland spills are of greatest concern since these spills would be in much closer proximity to the wetland resource. Spills from support vessels would be largely confined in navigation channels and canals. Slicks may quickly spread through the channel by tidal, wind, and vessel currents. Spills that damage wetland vegetation fringing and protecting canal banks would accelerate erosion of those once protected wetlands and spoil banks (Alexander and Webb, 1987).

Both coastal and offshore oil spills can also be caused by large tropical cyclone events such as Hurricanes Katrina, Rita, Gustav, and Ike. These types of storms can damage pipelines by physical movement or disconnection from the storm surge, eroding support structures and leading to pipeline breaks or damaging storage and destruction of refining facilities. Remnant winds and surges can potentially spread oil from platforms or distribution site on the OCS to the waters of the WPA depending on proximity.

While a resulting slick may cause minor impacts to wetland habitat, the equipment and personnel used to clean up a slick over the impacted area may 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 minimize or avoid those impacts. The fate and behavior of oil spills, the availability and adequacy of oil-spill containment and cleanup technologies, different oil-spill cleanup strategies, the impacts of oil-spill cleanup methods, the effects of weathering on oil, the toxicological effects of fresh and weathered oil, the air pollution associated with spilled oil, and the short- and long-term impacts of oil on wetlands are additional concerns.

Numerous investigators have studied the immediate impacts of oil spills on Gulf wetland habitats and other wetland habitats elsewhere similar to those affected by OCS activities. Often, seemingly contradictory conclusions are generated from these impact assessments. These contradictions can be explained by differences in many 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 vegetation that is lightly oiled would experience plant die-back, followed by recovery without replanting, so 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 Environmental Sensitivity Indices (ESI's) and, according to their expected retention of oil and some biological effects, they exhibit 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; however, 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.

Because 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, have 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 Texas coast are either 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.

Wetlands in Texas occur on a more stable substrate and receive more inorganic sediment per unit of wetland area than wetlands in Louisiana. Texas wetlands have not experienced the extensive alterations caused by rapid submergence rates and extensive canal dredging that affect Louisiana wetlands. The examinations of Webb and colleagues (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1987) are used to evaluate impacts of spills in these settings. The critical concentration of oil is that 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. Critical concentrations of different oils are unknown and expected to vary broadly for wetland types and plant species. Louisiana wetlands are assumed to be more sensitive to oil contact than elsewhere in the Gulf because of high cumulative stress. But for wetlands along more stable coasts (Texas), the critical oil concentration is assumed to be 1.0 L/m^2 (Alexander and Webb, 1983). Concentrations below the expected 1.0 L/m^2 would result in short-term, above-ground dieback for one growing season. Concentrations above this would result in longer-term impacts to wetland vegetation, including plant mortality extensive enough to require recolonization

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, which include 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 the 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), further 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).

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's 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 ecologist 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 determined not 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 is best to do nothing and let nature take its course. 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; and Mendelssohn et al., 1993).

Summary and Conclusion

Offshore oil spills resulting from a WPA proposed action are not expected to extensively damage any wetlands along the Gulf Coast. As noted above, wetland impacts from offshore spills would be minimized due to the distance of wells and production facilities to the coastal wetlands. In addition, the wetlands are provided protection by the barrier islands, peninsular ,sand spits, and currents. These factors, combined with the potential for highly weathered or treated oil reaching the shoreline, greatly minimize or eliminate the impacts of offshore spills. However, if an inland oil spill related to a WPA proposed action occurs, some impact to wetland habitat would be expected. The effects from a spill have the highest probability of occurring in Galveston County and Matagorda County, Texas. These are the primary areas where oil produced in the WPA is transported and distributed, and they are west of Plaquemines and St. Bernard Parishes, Louisiana, where oil produced in the CPA is handled. Although the probability of occurrence is low, the greatest threat of an oil spill to wetland habitat is from an inland spill as a result of a vessel accident or pipeline rupture. Wetlands in the northern Gulf of Mexico are either in moderate- to high-energy environments. Sediment transport and tidal stirring should reduce the chances of oil persisting in the event these areas are oiled. While a resulting slick may cause minor impacts to wetland habitat, the equipment and personnel used to clean up the spill can generate the greatest impacts to the area. Associated foot traffic can 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. Overall, impacts to wetland habitats from an oil spill associated with activities related to a WPA proposed action would be expected to be low and temporary.

4.1.1.4.4. Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a WPA proposed action, prior and future OCS activities, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may adversely affect wetlands during the life of a WPA proposed action. Impacts from residential, commercial, 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 and that 0-1 new pipeline landfalls and 0-1 new gas process facilities are possible. For further detail concerning coastal impact-producing factors, see **Chapter 3.1.2**. Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals, for maintenance of existing rig access canals and drill slips, and for the preparation of new well sites. Indirect impacts from dredging new canals for State onshore oil and gas development and from the maintenance of the existing canal network is expected to continue. Maintenance dredging of the OCS-related navigation channels accounts for 10 percent of the dredged material produced.

Locally, subsidence may be due to the extraction of large volumes of oil and gas from subsurface reservoirs, but subsidence associated with extractions seems to have slowed greatly over the last three decades as the reservoirs are depleted. Recent information indicates that subsurface transfer faults are adjusting to re-fill areas where salt has been evacuated, and these adjustments may be adding to the base subsidence along Gulf Coast (Stephens, 2010a).

Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed upon existing disposal areas. However, due to the fluid nature of the dredged material, indirect impacts may occur as a result of disposal site widening and converting lower elevations to higher ground. This elevation change could convert existing wetland areas to uplands. Also, alternative dredged material disposal methods can be used to enhance and create coastal wetlands. The COE's beneficial use requirements have created 1,250 ac (506 ha) of marsh per year over the last 25 years through its Beneficial Use of Dredged Materials Program (U.S. Dept. of the Army, COE, 2009c). Depending upon the region and the dredged soil type, 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 greater than 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 attributable to all human activities account for less than 12 percent of the total wetland loss experienced since 1930 and 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 percent 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 will afford the opportunity to create wetlands with the dredged materials. Deepening the Corpus Christi and Houston Ship Channels, which is non-OCS-related activity, should also afford the opportunity to create wetlands with dredged material.

The main factors that continually effect wetlands from OCS activities are dredging, navigation channels and canals, pipelines, oil spill, and development of wetlands. The following is a summary of these effects on the wetlands and how a WPA proposed action would not add significant negative effects to wetlands.

Dredging of Channels

Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts because a WPA proposed action is expected to use existing navigation channels and contribute minimally to the need for this dredging. Also, alternative dredged material disposal methods can be used to enhance and create coastal wetlands. 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 used beneficially for marsh restoration or creation. Through its beneficial use program, COE requires alternative dredged material disposal methods to be used to enhance and create coastal wetlands. The COE also requires alternate bank disposal of dredged material, which preserves the tidal hydrology and sheet flow within the marshes and, therefore, minimizes marsh loss. In a recent study that quantified erosion rates to determine whether differences in those rates were related to embankment substrate, vegetation type, geologic region, or soil type, it was found that substrate, vegetation cover, and rock armor were positive factors in reducing erosion (Thatcher et al., 2011). However, a WPA proposed action is expected to contribute minimally to the need for maintenance dredging; therefore, related impacts should also be minimal.

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. The primary support, transfer, and production facilities used for a WPA proposed action are located along armored canals and waterways; these armored canals and waterways minimize marsh loss.

Navigation Channels and Canals

The effects of pipelines, canal dredging, and navigation activities on wetlands are described in **Chapter 4.1.1.4.2**, ,and the subsidence of wetlands is discussed in more detail in **Chapter 4.1.1.4.1**.

Most navigation channels projected to be used in support of a WPA proposed action are shallow and are used by vessels that currently support the OCS Program (**Table 3-14**). Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process. This is evident along the Texas coast where heavy traffic using the Gulf Intracoastal Waterway (GIWW) has accelerated the erosion of existing salt marsh habitat (Cox et al. 1997). According to Johnson and Gosselink (1982), canal widening rates in coastal Louisiana range from approximately 0.95 m/yr (3.12 ft/yr) for canals with minimal boat activity to 2.58 m/yr (8.46 ft/yr) for canals with the greatest boat activity. Johnson and Gosselink (1982) found that vessel traffic is responsible for an average of 1.5 m/yr (4.9 ft/yr) of the canal widening. 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. Previous studies did not account for armored navigation channels and, therefore, likely overestimated loss from erosion. The Thatcher et al. (2011) study titled *Navigation Canal Bank Erosion in the Western and Central Gulf of Mexico* indicates that shoreline retreat rates along the canals were highly variable within and across unarmored portions of the navigation canals. It was noted that geology and vegetation type influenced the rate of shoreline change. In general, Thatcher et al. (2011) noted that the canal widening rate slowed from -1.71 m/yr (-5.61 ft/yr) for the earlier 1978/1979-1996/1998 time period to -0.99 m/yr (-3.25 ft/yr) for the 1996/1998-2005/2006 time period. A current BOEM study (Snedden, in preparation) was reviewed and coordinated with the Louisiana Department of Natural Resources' Office of Coastal Management to better understand salinity behavior as it relates to marshes adjacent to the navigation canals. The BOEM has funded the USGS' National Wetlands Resource Center, through an Interagency Agreement, to perform the 2-year study. Initial work began in January 2010 and is scheduled for completion in 2012.

About 700 km (435 mi) of these channels support OCS-related activities in the WPA. Total navigation use (OCS and non-OCS) of those channels results in about 105 ha (259 ac) of landloss each year. Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, saltwater penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish water to saltwater and ultimately to open-water systems. Another example is the construction of the Mississippi River Gulf Outlet, which transformed many of the cypress swamps east of the Mississippi River below New Orleans into open water or areas largely composed of marsh vegetation (*Spartina)* among old, dead cypress tree trunks.

Landloss would continue from subsidence induced by saltwater intrusion especially in the areas behind the beach heads degraded or channelized by the cumulative effects of Hurricanes Katrina, Rita, Gustav, and Ike. Hurricane Ike, specifically, damaged the large beach heads around High Island, McFaddin National Wildlife Refuge, and the Bolivar Peninsula (Texas). This damage provided a pathway for saltwater intrusion into the marshes behind those beach heads. Landloss would continue from vessel traffic; however, due to the minimal increase in traffic caused by a WPA proposed action, the loss would be minimal. A WPA proposed action would not require any additional channel maintenance; therefore, no additional wetland loss would result from dredged material disposal. If dredged material disposal is required, it may be beneficially used for marsh creation. Vessel trips associated with a WPA proposed action are estimated to be 64,000-75,000 vessel trips over 40 years, and 481,000-720,000 vessel trips are projected for OCS activities in the WPA over the 40 year period (2012-2051) (**Tables 3-2 and 3-5**). Disposal of OCS wastes and drilling by-products will be delivered to existing facilities; no additional wetland acres would be utilized.

As noted in the **Chapter 4.1.1.4.2**, the previous OCS activities associated with the WPA 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 and onshore action needed for the construction of new well sites and expansion or construction of onshore and offshore facilities (production platforms or receiving and transfer facilities). Most of these facilities would be located in Louisiana and would minimally impact wetlands in the WPA. 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).

Impacts to coastal areas resulting from activities related to navigation canals can be mitigated with bank stabilization and, where possible, the use of dredged material (produced during maintenance dredging activities) to create wetland or upland habitats. The service vessels associated with a WPA proposed action would generate an estimated 64,000-75,000 trips, which is 2 percent of the total OCS traffic (9% of all vessel traffic) generated in the Gulf of Mexico. Based on these estimates, the vessel-induced erosion associated with a WPA proposed action is minimal.

Pipelines

Modern pipeline installation methods that use horizontal (trenchless) drilling allows pipelines to be installed under coastal habitats such as barrier islands and beaches as well as fringe marshes, and therefore, eliminates or greatly reduces impacts to these habitats. The addition of corrosion preventatives to the pipeline itself reduces the probability of accidental leakage from aging pipelines. These techniques, in combination with "tie ins" to existing Federal or State pipelines with shore connections, further reduces the number of new pipeline landfalls and their cumulative impact. While impacts are greatly reduced by mitigation techniques, remaining impacts may include expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment transport, and habitat conversion (Cox et al., 1997; Morton, 2003; Ko and Day, 2004b). The majority (over 80%) of OCS-related direct landloss is estimated to be from OCS pipelines (Turner and Cahoon, 1987). 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, and they mainly occur in Louisiana. The remaining 7,400 km (4,595 mi) cross waterbodies (Johnston et al., 2009). The total length of non-OCS 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 (OCS and non-OCS) of approximately 23,285 km (14,460 mi) of pipelines through Louisiana coastal wetlands. The majority of OCS pipelines entering State waters ties into existing pipeline systems and does not result in new landfalls. Pipeline maintenance activities that disturb wetlands are very infrequent and are mitigated to the maximum extent practicable.

The widening of OCS 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 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. Today, 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-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 attributed to significant habit changes. Impacts can be minimized or altogether avoided through proper construction methods, mitigation, and maintenance. The BOEM is not a permitting agency for onshore pipelines. The permitting agencies are COE and the State in which the activity has or would occur. 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.

Throughout the 40-year life of a WPA proposed action, a majority of the already old pipeline distribution and production systems would continue to age. This could result in an increasingly large inventory of pipelines and support structures that would need to be replaced or repaired. The replacement and repair of the inland pipeline system may temporarily impact wetlands in the pipeline corridors, but if proper mitigation is implemented and maintained, impacts should be minimal and temporary. In the absence of the replacement of these aging pipelines, the potential risk for spills and leaks will increase in nearshore, inland, and offshore waters.

Oil Spills

The potential for oil spills would continue with coastal/inland spills. This creates the greatest concern for coastal wetlands due to the proximity of the spills to these vegetated areas. Aging infrastructure including refineries, onshore production facilities, platforms, and pipelines would continue to be an increasing source of potential spills both inland and offshore. 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). Improperly capped or marked abandoned wells also add to the possibility for future oil spills as a result of leaks or vessel collisions. The surge from Hurricane Ike caused damage to many oil production facilities in the Goat Island and High Island area of Texas and resulted in the release of oil that affected approximately 1,011-1,214 ha (2,500-3,000 ac) of wetlands (Gable, 2008). An estimated additional 1,497 ha (3,700 ac) of Federal and State refuges were also affected with varying degrees of oiling resulting from the storm-damaged facilities. Future spills from these types of facilities would be less likely because these older facilities are either structurally updated to withstand larger storms or replaced.

Oil from offshore spills is less likely to reach the coastal wetlands in a fully toxic condition due to weathering, dispersant treatment, and the blockage of spills by barrier islands. However, any reduced elevation and erosion of these barriers by Hurricanes Katrina, Rita, and Ike decrease the level of protection afforded the mainland (USDOC, NMFS, 2007a; Doran et al., 2009). Hurricane Ike severely damaged the Bolivar Peninsula, especially the protective beaches and dunes around High Island, Crystal Beach, and the National and State wildlife refuges (Doran et al., 2009). Dunes were lowered and inlets were cut into the beach face, which allowed saltwater intrusion into the once-protected wetlands behind these beaches. In some areas, freshwater ponds emptied through the intertidal channels cut by the storm and robbed wetlands of a freshwater supply. This reduced protection from the beach heads and dunes can also allow oil to penetrate further into the mainland and fringe marshes. 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. This oil contributes less than 0.1 L/m^2 on wetland surfaces (Doran et al., 2009). Any adverse impacts that may occur to wetland plants are expected to be very short lived, probably less than 1 year. Coastal OCS spills could occur as a result of pipeline accidents and barge or shuttle tanker accidents during transit or offloading. The frequency, size, distribution, and impact of OCS coastal spills are provided in **Chapter 3.2.1.7**.

Non-OCS 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 3.2.1.7**. Numerous wetland areas have declined or been destroyed as a result of oil spills caused by pipeline breaks or tanker accidents.

Oil stresses the wetland communities, making them more susceptible to saltwater intrusion, drought, disease, and other stressors (Ko and Day, 2004a). 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 (**Chapter 3.1.1.4.2**).

The numbers and sizes of coastal spills in both the CPA and WPA are presented in **Table 3-21**. Based on the assumption that spill occurrence is proportional to the volume of oil handled, sensitive coastal environments in western 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. In the waters 0-3 nmi (3.5 mi; 5.6 km) off the Texas coast, there were a total of 250 spills reported from

1996-2009 or about 20 spills <1,000 bbl/yr. Roughly one-quarter of the spills were from oil and gas sources, half were due to activities not related to oil and gas, and the final quarter were due to unknown sources. Assuming that all spills designated with unknown source were actually due to State or Federal oil and gas activity, there were close to 125 spills <1,000 bbl (~10 spills <1,000 bbl/year) in the Texas coastal waters. The BOEMRE (2011a, Figure 1) shows that 96 percent of Federal oil and gas activity spills are <1 bbl with an average size of 0.05 bbl and 4 percent of Federal oil and gas activity spills are 1-999 bbl with an average size of 77 bbl. Although this is a rough approximation, 20-30 bbl/yr spills from State or Federal oil and gas activity into the waters 0-3 nmi (3.5 mi; 5.6 km) off Texas annually. The great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from OCS-related activity would originate near terminal locations in the coastal zones of Texas, Louisiana, Mississippi, and Alabama but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana.

Development of Wetlands

The development of wetlands for agricultural, residential, and commercial uses would continue but with more regulatory and planning constraints. 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), Louisiana's Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), and Louisiana Coastal Protection and Restoration Project (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 Gulf waters and will not affect coastal wetlands (**Chapter 3.1.1.4.2**).

The major ports supporting the offshore facilities are still primarily located in Louisiana waters even though production may be transported to Texas. Dredged material will be deposited either in existing approved discharge sites or will be used beneficially for wetland restoration or creation. In Port Fourchon, Louisiana, some of the existing areas being filled with dredged material may be used for the expansion of oil production or support facilities. Currently, the CWPPRA program is actively engaged in restoring the protective headlands in the Fourchon area. In Texas, the J.D. Murphree State Wildlife Management Area complex is undergoing restoration in an effort to reestablish beach face and protective dunes that were removed by Hurricane Ike.

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 buildings 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 marsh or changes in marshes, marsh types, and plant diversity (Spalding and Hester, 2007). The Spalding and Hester (2007) study shows that the very structure of coastal wetlands would likely be altered by sea-level rise because community shifts will be governed by the responses of individual species to new environmental conditions. Flood control and channel training along the Mississippi River will 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, but 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).

As a result of the increase in frequency and intensity of tropical storms and hurricanes in the last 6 years, both natural and developed coastal communities have been severely damaged. In order to minimize or prevent future damages resulting from these storms, changes have been made in regulations regarding coastal development and government-funded projects for coastal restoration. Future coastal development is expected to be more environmentally compatible with the natural protective features of the coast (wetlands, dunes, and barrier islands). This is because Federal, State, and local regulatory and natural resource agencies cooperatively plan coastal development.

Summary and Conclusion

Wetlands are most vulnerable to inshore or nearshore oil spills primarily localized in nature. Spill sources include vessel collisions, pipeline breaks, and shore-based transfer, refining, and production facilities. The wetlands associated with a WPA 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 reduced locally post-Hurricanes Katrina, Rita, Gustav, and Ike), 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, and weather. Offshore spills related to a WPA proposed action are not expected to reach wetlands in toxic conditions because of distance to shore and weathering. If they do reach shore, only light localized impacts to inland wetlands would occur. If any inshore spills occur, they will likely be small and at service bases or other support facilities, and these small-scale local spills would not be expected to severely affect wetlands.

As a result of Hurricane Ike, some of the State and national wildlife refuges along the eastern Texas coast will continue to experience some landloss through storm-induced saltwater intrusion. However, coastal restoration projects are either ongoing or planned to restore the natural protection to the marshes in these refuges and management areas. Landloss will continue from vessel traffic; however, because of the minimal increase in traffic caused by a WPA proposed action, this loss would be minimal. A WPA proposed action will not require any additional channel maintenance; therefore, no additional wetland loss would result from dredged material disposal. If dredged material disposal is required, it may be beneficially used for marsh creation. Disposal of OCS wastes and drilling by-products will be delivered to existing facilities. Because of existing capacity, no additional expansion into wetland areas will be expected.

Development pressures in the coastal regions of Texas have been primarily the result of tourism and residential beach side development in the Galveston and Bolivar Peninsula areas. In Galveston, recreation and tourist developments have been particularly destructive. These trends are expected to continue, but since Hurricane Ike, redevelopment is being coordinated with the natural resource agencies in an effort to assure compatibility of the new construction with the coastal environment to minimize impacts.

If pipelines are needed, the modern construction techniques and mitigation measures would result in zero to negligible impacts on wetland habitats because modern techniques avoid wetlands through selective emplacement in existing corridors, directional drilling to avoid additional trenching, and required restoration and revegetation techniques. A WPA proposed action represents a small (>5%) portion of the OCS impacts that will occur over the 40-year analysis period. Impacts associated with a WPA 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. Wetland loss is also expected to continue in coastal Texas, but at slower rates. The incremental contribution of a WPA proposed action to the cumulative impacts to coastal wetlands is expected to be small. The primary impacting factors attributable to a proposed action are pipeline landfalls, canal widening, and maintenance dredging of navigation canals. However, activities associated with a WPA proposed action require no additional navigation canals; at most, it would require one new pipeline landfall and no increase in channel maintenance of existing channels. The use of existing onshore processing and transfer facilities and existing pipelines in established transportation corridors eliminates the need for dredging or construction activities that would cause additional wetland losses as a result of a WPA proposed action. A WPA proposed action would use existing disposal sites approved for receiving OCS related wastes; therefore, no additional wetlands would be needed for this purpose.

4.1.1.5. Seagrass Communities

The full analyses of the potential impacts of routine activities and accidental events associated with a WPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in this EIS. This is a brief summary of the potential impacts. Turbidity impacts from pipeline installation and maintenance dredging associated with a WPA 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 WPA 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 WPA proposed action would cause a minor incremental contribution to cumulative impacts due to dredging from maintenance of channels.

4.1.1.5.1. Description of the Affected Environment

This is a detailed description of seagrass communities in the WPA (Texas and because of its close proximity to the area, Louisiana is also discussed). This information is from searches that were 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 submerged aquatic vegetation (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 foraging 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 provide 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; over 80 percent of these beds are in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). Only a rough estimate of the extent of seagrass beds in Texas could be made with the available data, approximately 80,000 ha (197,684 ac). 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). In the WPA, the most abundant seagrass species is *H. beaudettei* (Adair et al., 1994; Texas Parks and Wildlife, 1999). 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). For example, in Texas, construction and maintenance of the Gulf Intracoastal Waterway and the "Texas brown tide" event in the 1990's contributed to the decline in seagrass beds in the Laguna Madre (Pulich and Onuf, 2007). The USGS's *Seagrass Status and Trends 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.

Seagrasses in Texas are mostly found in widely scattered beds in shallow, high-salinity coastal lagoons and bays that are protected by barrier islands. These systems support highly diverse and productive communities and are important resources of the Texas coast (Pulich and Onuf, 2007). Although permanent meadows of perennial species occur in nearly all bay systems along the Texas Gulf Coast, most of the State's seagrass cover is found in the Laguna Madre, a large body of shallow water separating Padre Island from the south Texas mainland (Onuf, 1996; Texas Parks and Wildlife Department, 1999; Pulich and Onuf, 2007). Throughout the rest of Texas, lower-salinity SAV beds are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays (Texas Parks and Wildlife Department, 1999). In the past 5 years, seven tropical cyclone events (Tropical Storm Erin and Hurricane Humberto in 2007, Tropical Storms Dolly and Edouard and Hurricane Ike in 2008, and Hurricane Alex and Tropical Storm Hermine in 2010) have passed over/made landfall near Texas (USDOC, NOAA, 2010c). Three of the storms were near Galveston or the Texas-Louisiana border, which has higher abundances of SAV, and four of these storms (Erin, Dolly, Alex, and Hermine) were south of Padre Island where there are high abundances of seagrass (USDOC, NOAA, 2010c). Submerged vegetation can be 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 (Fourqurean and Rutten, 2004). There has been little published on the possible effects of these storms on local submerged vegetation communities, but general storm effects are discussed in **Chapter 4.1.1.5.4**.

Along the Louisiana coast, submerged vegetation primarily consists of freshwater and low salinity SAV's, and these beds are found in coastal waterbodies like Lake Pontchartrain, Biloxi Marsh, and the Barataria-Terrebonne estuary (Maiaro, 2007; Poirrier et al., 2010). This is largely due to the turbid water conditions that are caused by the Mississippi and Atchafalaya Rivers. Thus, seagrass beds in Louisiana have low densities and are rare (Poirrier, 2007). Submerged beds in Louisiana are often affected by storm events of different severities, which dictate recovery times 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 or on the Louisiana coast. Hurricane Humberto (2007) and Tropical Storm Edouard (2008) hit near the Texas/Louisiana borders, and Hurricane Gustav (2008) made landfall near Cocodrie, Louisiana (USDOC, NOAA, 2010c). 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 local submerged grass communities with wind force (USDOC, NOAA, 2010c). Strong storm events not only removed seagrass and SAV beds but they also changed 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 4.1.1.5.4**.

As noted above, there remains uncertainty regarding the impacts of the DWH event on submerged vegetation in Louisiana, which is in the CPA. The Macondo well, however, was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary (**Figure 1-2**). Data collected by the Operational Science Advisory Team indicate that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). As such, seagrass and SAV communities in the WPA are not believed to have been impacted by the DWH event; therefore, even though there is incomplete or unavailable information regarding the impacts of the DWH event on seagrasses in Louisiana, this information is not essential to a reasoned choice among alternatives for a WPA proposed lease sale.

4.1.1.5.2. Impacts of Routine Events

Background/Introduction

The routine events associated with OCS activities in the WPA 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 are greater than those for pipeline installations because it creates a much wider and deeper footprint. A WPA proposed action, however, is only likely to result in 0-1 pipeline landfalls. Pipelines are heavily regulated and permitted, and are likely to be required to be sited away from submerged vegetation. If implemented, 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. These activities decrease the local seagrass beds in Laguna Madre, Texas (Texas Parks and Wildlife Department, 1999). Deepwater oil and gas exploration requires larger vessels that produce large wakes that could cause erosion and channel widening; however, the deepwater ports are expected to remain the same so the damage would not increase with a proposed action. In Texas, there are 11 ports including ones in Galveston, Freeport, and Port O'Connor (**Table 3-13**; **Figure 3-7**). In Louisiana, the main deepwater ports are located in Fourchon and Venice. Cameron, Intracoastal City, and Morgan City also support heavy vessel support activity but there are 14 ports in the state (**Table 3-13**; **Figure 3-7**). 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 WPA 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 will negatively affect 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 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, actions such as using turbidity curtains or silt dams with a sizable barrier can alleviate dredge effects. When possible, dredge 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. About 13 active OCS pipelines currently cross the Federal/State boundary into Texas waters and make landfall and 109 into Louisiana waters and make landfall. There are 0-1 new pipelines projected in State waters and to make landfall as a result of a proposed action from the OCS Program in the WPA. Most activities will use existing inshore structures, so less than one pipeline per year will make landfall under a WPA proposed action. These activities are discussed in **Chapter 3.1.2.1.6**. If any new pipelines run to shore due to a WPA proposed action, environmental permit requirements for locating pipelines will 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 from 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 OCS and non-OCS vessel 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 WPA 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, commercial shipping, cruise ships, fishing vessels, and recreational watercraft) is an increasing concern along the Texas coast (Dunton et al., 1998; Texas Parks and Wildlife Department, 1999; Pulich and Onuf, 2007). 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 varies 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 if an already stressed bed is damaged, it could take decades to recover. Scarring may have a more critical effect on habitat functions in areas with less submerged vegetation, like those found in Louisiana. The State of Texas, with the help and support of Texas Parks Service, Texas General Land Office, researchers, and sportsmen has instituted management programs to reduce scarring (Texas Parks and Wildlife Department, 1999). These programs include education, channel marking, increased enforcement, and limited-motoring zones. Initial monitoring results indicate that scarring seems to be declining in protected areas. 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 WPA that may impact seagrasses are not predicted 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 undesirable effects on submerged vegetation beds from dredging activities. These Federal and State permit requirements should ensure pipeline routes avoid high-salinity beds and should maintain water clarity and quality. Local programs decrease the occurrence of prop scarring in grass beds, and generally, channels used by OCS vessels are away from exposed submerged vegetation beds. Because of these requirements, implemented programs, along with the beneficial effects of natural flushing (e.g., from winds and currents), any potential effects from routine activities on seagrasses and SAV's in the WPA are expected to be short term, localized, and not significantly adverse.

Impacts to submerged vegetation from routine activities of a WPA proposed action are expected to be minimal because of the distance of most activities from the submerged vegetation beds, because the 0-1 pipeline landfall and maintenance dredging would be heavily regulated and permitted, and because mitigations (such as turbidity curtains and siting away from beds) may be required.

4.1.1.5.3. Impacts of Accidental Events

Background/Introduction

Within the WPA, much of the seagrass cover is in Texas and is located in the Laguna Madre (Onuf, 1996; Texas Parks and Wildlife Department, 1999; Pulich and Onuf, 2007). There are also lower-salinity SAV beds inland and discontinuously in Texas' coastal lakes, rivers, and the most inland portions of some coastal bays (Texas Parks and Wildlife Department, 1999). In eastern Louisiana, submerged vegetation primarily consists of freshwater and low-salinity vegetation (SAV) (Poirrier, 2007). Accidental impact-producing factors from a WPA proposed action are discussed in **Chapter 3.2**.

Proposed Action Analysis

Accidental events possible with a WPA proposed action that could 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 massive, an offshore spill could affect submerged vegetation communities.

The probabilities of a spill ≥1,000 bbl related to a WPA proposed action occurring and contacting environmental features are described in **Chapter 3.2.1.5.7**. The mean estimated number of offshore spill events over the 40-year life of a WPA proposed action is <1 spill for spills ≥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 3-9** provides the results of the OSRA model that calculated the probability of a spill ≥1,000 bbl occurring offshore as a result of a WPA proposed action and reaching a Gulf Coast parish or county.

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. Nine counties in Texas have a chance of spill contact >0.5 percent, with Matagorda having the greatest probability at 3 percent after 30 days; the other counties have a <2 percent chance of an OCS offshore spill ≥1,000 bbl occurring. Cameron parish in Louisiana is the only parish that has a probability of a spill contacting its coast that is >0.5 percent. For this parish, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching its shoreline is <0.5 percent to 1 percent. Inshore spills may result from either vessel collisions or ruptured pipelines that release crude and condensate oil. The Galveston/Houston/Texas City area has the greatest risk of experiencing coastal spills related to a WPA 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 faunal communities (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 can settle and coat the 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 causes 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). There is increased boat and human traffic in these sensitive areas that are generally 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 in Texas and Louisiana is found in **Chapter 4.1.1.5.1**.

Summary and Conclusion

Although the size would be small and the duration is quick, 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 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 will decrease detrimental effects to submerged vegetation from a WPA proposed action.

As noted above in the affected environment section, there remains uncertainty regarding the impacts of the DWH event on submerged vegetation in Louisiana, which is in the CPA. The Macondo well, however, was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary (**Figure 1-2**). Data collected by the Operational Science Advisory Team indicate that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). As such, seagrass and SAV communities in the WPA are not believed to have been impacted by the DWH event; therefore, even though there is incomplete or unavailable information regarding the impacts of the DWH event on seagrasses in Louisiana, this information is not essential to a reasoned choice among alternatives for a WPA proposed lease sale.

Impacts to submerged vegetation from an accidental event related to a WPA proposed action are expected to be minimal due to the distance of most activities from the submerged vegetation beds and that the likelihood of an accidental event of size, location, and duration reaching submerged vegetation spills remains small.

4.1.1.5.4. Cumulative Impacts

Background/Introduction

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.

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 WPA is expected only in areas that do not support submerged vegetation beds. Maintenance dredging will 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 WPA. Maintenance dredging and vessel traffic related to a WPA 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 can affect 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 Texas and Louisiana. Mitigation may be required to reduce undesirable impacts of dredging to submerged vegetation. Maintenance dredging of navigation channels from COE helps sustain the outcome of the original dredging event. This occurs generally every 2-5 years despite a proposed action. There is expected to be few if any new channels dredged or widened for a WPA proposed action. From 2012 to 2051, offshore oil and gas activities are projected to generate 0-1 pipeline landfalls in Texas and Louisiana; this is equivalent to less than 1 pipeline a year for a proposed action. 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 4.1.1.5.2**.

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 WPA. 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 only a 3 percent probability of an offshore oil spill making any contact with submerged vegetation beds in the WPA and because inshore spills would be small and short-lived, oil exposure is not expected to increase over current levels with a WPA proposed action. Oil-spill effects on submerged vegetation are discussed in more detail in **Chapter 4.1.1.5.3**.

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 have instituted management programs that have resulted in reduced scarring, which could decrease bed patchiness (Texas Parks and Wildlife Department, 1999). 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 4.1.1.5.2**.

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 Texas and 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 is in Louisiana with 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). 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 (Larkum et al., 2006; Orth et al., 2006). This relationship is complex and depends on multiple environmental factors. A WPA proposed action is not going to significantly change flow regimes or add to eutrophication in the WPA.

Currently, there is a period of significant increased tropical cyclone activity in the Gulf of Mexico (USDOC, NOAA, 2005). 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 WPA is presented in **Chapter 4.1.1.5.1**. 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. Global climate change can increase surface water temperature, sea levels, and storm events (Orth et al., 2006). Whether it is from anthropogenic activities or a cycle, it has effects on seagrass beds by adding stress to this sensitive and already stressed ecosystem (Orth et al., 2006). A WPA proposed action is not expected to significantly increase the effects from a natural disturbance.

Summary and Conclusion

In general, a WPA proposed action would cause a minor incremental contribution to impacts on submerged vegetation from dredging, pipeline installations, potential 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 WPA 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 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 based upon accepted methods and approaches. Nevertheless, BOEM believes that incomplete or unavailable information regarding the effects of DWH event 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 WPA proposed action remains minor compared with the cumulative effects of other factors, including dredging, hurricanes, and vessel traffic.

4.1.1.6. 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 WPA 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). Some other banks, such as the south Texas banks, are relic coral reefs left over from the last sea-level low stand (about 10,000 years ago). 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 (https://www.boemre.gov/homepg/regulate/regs/ntls/2009NTLs/09-G39.pdf) includes drawings of each bank with associated protection zones (USDOI, MMS, 2009a).

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. A full analysis of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a WPA proposed action are presented in this EIS.

Note that, although the Flower Garden Banks National Marine Sanctuary is discussed below in the impacts analysis, neither of the Action Alternatives of a WPA proposed action would offer any full or partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary.

4.1.1.6.1. 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. Some others, such as the South Texas Banks, are relic coral reefs left over from the last sea-level low stand (about 10,000 years ago). 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 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 protected topographic features in the Gulf of Mexico. 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 (Gardner et al., 2002).

A total of 22 topographic features are protected in the WPA. 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. The NTL 2009-G39 also recommends that drilling would 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; any construction within the buffer would require project specific EFH consultation with NMFS.

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 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) will 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 close to the muddy seafloor and are bathed most of the year in nutrient-poor waters (Rezak et al., 1990). The East and West Flower Garden Banks (**Figure 4-6**) are the principal examples of such suitable substrates. Average turbidity values at the Flower Garden Banks (<11 nephelometric units) correspond to turbidity levels that do not affect the photosynthesis and respiration of hermatypic corals (Precht et al., 2006). The depth of these banks (15 m [49 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 wave influence from the strongest storms can reach 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/updated 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 found predominantly at the East and West Flower Garden Banks (**Figure 4-5**). The dominant species/groups 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, at both banks. Red turf algae (primarily Order Ceramiales) is the dominant algal group at the East and West Flower Garden Banks and has increased in percent cover substantially over the last several years. Dokken et al. (2003) reported algal percent cover at both banks was significantly greater during 1999 than during 1998. Macroalgal cover was reportedly high in 2005 and increased in 2006 after the passing of Hurricane Rita (Precht et al., 2008; Robbart et al., 2009). Monitoring of random transects on the East and West Flower Garden Banks before Hurricane Rita indicated that percent coral cover was between 50 percent and 65 percent, which was similar to overall coverage after the passing of the storm and through surveys in 2007 (Precht et al., 2008; Robbart et al., 2009; Cadlow et al., 2009). There was evidence, however, of high levels of bleaching (up to 46% of individual colonies) in 2005 due to elevated water temperatures, which was significantly reduced (4%) the following year (Hickerson et al., 2008). Historical data indicate recovery after such events and overall community stability at the Flower Garden Banks (Gittings, 1998; Precht et al., 2008).

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). This high-diversity *Diploria/Montastraea/Porites* Zone is found only at the East and West Flower Garden Banks in water depths less than 36 m (118 ft) (Rezak et al., 1990).

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 the Flower Garden Banks. 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. 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. 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 organisms 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 Western Planning Area

Shelf-Edge Banks	Midshelf Banks	South Texas Banks
Appelbaum Bank	29 Fathom Bank	Aransas Bank
East Flower Garden Bank	32 Fathom Bank	Baker Bank
MacNeil Bank	Claypile Lump	Big Dunn Bar
Rankin Bank	Coffee Lump	Blackfish Ridge
West Flower Garden Bank	Stetson Bank	Dream Bank
		Hospital Bank
		Mysterious Bank
		North Hospital Bank
		Small Dunn Bar
		South Baker Bank
		Southern Bank

Figures 4-6 and 4-7 illustrate the topographic relief associated with several of the more developed features, i.e., the East and West Flower Garden Banks and Stetson Bank.

Shelf-Edge Banks

The shelf-edge banks of the WPA generally exhibit the *Diploria-Montastraea-Porites* zonation that is exhibited at the East and West Flower Garden Banks at comparable depths (see **Figures 4-5 and 4-6** for the location and vertical relief of the banks) (Rezak et al., 1983). Dominant coral species include *Montastraea annularis*, *Diploria strigosa*, *Montastraea cavernosa*, *Colpophyllia* spp., and *Porites astreoides* (Rezak et al., 1983). Crustose corraline algae and many species of reef fish are abundant in this zone. The dominant species transition below the 36- to 38-m (118- to 125-ft) depth, in the Stephanocoenia-Millepora Zone to *Stephanocoenia michelini*, *Millepora* spp., *Montastraea cavernosa*, *Colpophyllia* spp., *Diploria* sp., *Agaricia* spp., *Mussa angulosa*, and *Scolymia* sp. Crustose corraline algae, black urchin, and American thorny oyster are also present. Leafy algae (*Stypopodium*, *Caulerpa*, *Dictyota*, *Chaetomorpha*, *Pocockiella*, *Rhodymenia*, *Valonia*, and *Codium*) and the branching coral, *Madracis mirabilis*, may also be present in the Leafy Algae and Madracis Zones, at depths of 28-46 m (118-125 ft) on these Banks (Rezak et al., 1983). Between 46 and 82 m (151 and 269 ft), the Algal-Sponge Zone persists and is dominated by coralline algae that form rhodoliths upon which other organisms attach. Calcareous green algae, hermatypic corals, deepwater alcyonarians, antipatharian whips, sponges, and echinoderms are all present in this zone (Rezak et al., 1983). This section is a partially drowned reef environment, as it is at a depth where hermatypic corals have limited growth abilities. Drowned reefs, at depths too great for hermatypic coral growth and limited coralline algal growth, are below the Algal-Sponge Zone and consist of Comatulid crinoids, deepwater octocoral whips, octocoral fans, antipatharians, encrusting sponges, and solitary ahermatypic corals (Rezak et al., 1983). The water is generally turbid in this Antipatharian Zone and the reef is covered with sediment. Species numbers and diversity decrease with depth (Rezak et al., 1983).

Midshelf Banks

Three midshelf banks in the WPA contain the *Millepora*-Sponge Zone: Stetson; Claypile; and 29 Fathom Banks (**Figure 4-5)**. The nepheloid layer often enfolds Claypile Bank, which is considered a low-relief bank with only 10 m (33 ft) of relief. Therefore, the level of development of the *Millepora*-Sponge community is lowest at Claypile Bank. Low growing leafy and filamentous algae, including attached *Sargassum*, have been observed on Claypile Bank, along with a few large coral heads of *Stephanocoenia michelini* (Rezak et al., 1983). Two other midshelf banks in the WPA (32 Fathom Bank and Coffee Lump) are also low-relief banks with less than 10 m (33 ft) of relief. Coffee Lump Bank is predominated by antipatharian whips, comatulid crinoids, encrusting coralline algae, sponges, hydroids, serupilid worms, and hermatypic agariciid corals, and it is often covered with a sediment veneer (Rezak et al., 1983).

Stetson Bank (**Figure 4-7**) is isolated from other banks and lies near the northern physiological limit for the advanced development of reef-building hermatypic corals. The species composition is markedly different from that of other tropical reefs including the Flower Garden Banks. In addition to the *Millepora*-Sponge characteristics at Stetson Bank, there are sparsely distributed hermatypic (reef-building) and ahermatypic (nonreef-building) coral species found. Hermatypic corals are found at Stetson Bank in scattered patches and include *Diploria strigosa*, *Stephanocoenia intersepta*, *Madracis decactus*, *Madracis mirabilis*, and *Agaricia fragilis* (DeBose et al., 2008). Recently, an invasive nudibranch, *Thecacrea pacifica*, has been reported at Stetson Bank (Hickerson et al., 2008). In addition to Stetson's unique landscape and topographic features (**Figure 4-5**), there is an abundance of marine life residing at the bank. Over 180 species of reef and schooling fishes and 644 species of invertebrates are documented (DeBose et al., 2008). Due to its vertical orientation (steep-sided crests within 23 m [75 ft] of the sea surface), Stetson Bank attracts a number of pelagic species that move back and forth across the continental shelf utilizing various banks, including the Flower Garden Banks, for seasonal feeding, mating, and as nursery grounds. These large pelagic animals include species such as manta and devil rays and the filter-feeding whale shark (DeBose et al., 2008; USDOC, NOAA, 2010d).

South Texas Banks

The South Texas Banks are geographically/geologically distinct from the shelf-edge banks. Several of the South Texas Banks are also low-relief banks. These banks exhibit a reduced biota and have relatively low relief, few hard-substrate outcrops, and a thicker sediment cover than the other banks (Rezak et al., 1983).

The South Texas Banks are generally inhabited by species typical of the Antipatharian Zone. Observations from Baker Bank (**Figure 4-5**), which had a similar benthic composition to other South Texas Banks, included black coral (*Cirrhipathes*), vase sponge (*Ircinia campana*), comatulid crinoids, sea fans, deepwater alcyonarians, small solitary corals, gorgonocephalan basket stars, American thorny oyster (*Spondylus americanus*), brachiopods (*Argyrotheca barrettiana*), arrow crabs (*Stenorhynchus seticornis*), hermit crabs, black urchin (*Diadema antillarum*), sea cucumber (*Isostichopus*), and fireworms (*Hermodice*) (Rezak et al., 1983). Resident fish species included yellowtail reeffish, roughtongue bass, spotfin hogfish, reef butterflyfish, wrasse bass, tattler, gobies, and blue angelfish (Rezak et al., 1983).

Migratory game and commercial fishes—red snapper, Vermilion snapper, greater amberjack, great barracuda, small carcharhinid sharks, and cobia—also inhabit the South Texas Banks (Rezak et al., 1983).

It has been suggested that three other South Texas features in the WPA be considered as sensitive offshore topographic features: Sebree, Big Adam, and Small Adam Banks. Sebree Bank (**Figure 4-5**), located in 36.5 m (120 ft) of water, is a low-relief feature of approximately 3 m (10 ft) in relief and is located in an area subject to high sedimentation. Clusters of the scleractinian coral, *Oculina diffusa*, have been observed on the rocky outcrops of this bank. This species tends to thrive in habitats exhibiting low light and high sedimentation. In the GOM, it forms branched, low-relief, generally round colonies, and does not create reefs or distinctive assemblages of reefal species. The most common fish associated with Sebree Bank were red snapper and tomtate grunt (Tunnell, 1981). Findings in the August 1993 cooperative dive effort on Sebree Bank by this Agency, the State of Texas, and Texas A&M University at Corpus Christi (Dokken et al., 1993) were generally consistent with those reported by Tunnell (1981). Dokken et al (1993) also reported sponges, hydroids, octocorals, and nonhermatypic corals present on the banks, although large areas of the reef were barren.

Dokken et al. (1993) compared the nepheloid-dominated, low-diversity community of Sebree Bank with the Nepheloid Zone community described by Rezak et al. (1985). Rezak and Bright (1981) devised an environmental priority index to rate the sensitivity of topographic features in the northern GOM.

- South Texas midshelf relict Pleistocene carbonate reefs bearing turbidity tolerant Antipatharian Zone and Nepheloid Zone (surrounding depths of 60-80 m (197-262 ft), crests 56-70 m (184-230 ft)).
- North Texas-Louisiana midshelf, Tertiary-outcrop banks bearing clear-water, *Millepora*-Sponge Zone and turbid-water-tolerant Nepheloid Zone (surrounding depths of 50-62 m (164-203 ft), crests 18-40 m (59-131 ft).
- North Texas-Louisiana midshelf banks bearing turbidity-tolerant assemblages approximating the Antipatharian Zone (surrounding depths of 65-78 m (213-256 ft), crests 52-66 m (171-216 ft)).
- North Texas-Louisiana shelf-edge, carbonate banks bearing clear-water coral reefs and Algal-Sponge Zones, transitional assemblages approximating the Antipatharian Zone and Nepheloid Zone (surrounding depths of 84-200 m (276-656 ft), crests 15-75 m (49-246 ft)).
- Eastern Louisiana shelf-edge, carbonate banks bearing poorly developed elements of the Algal-Sponge Zone, transitional Antipatharian Zone assemblages, and Nepheloid Zone (surrounding depths of 100-110 m (328-361 ft), crests 67-73 m (220-240 ft).

Rezak and Bright (1981) categorized similar features containing Nepheloid Zone communities as banks where protection is not recommended. Since Sebree Bank (**Figure 4-5**) is located within a shipping fairway, it is relatively well protected from physical impacts (anchoring or drilling disturbance). While they did not specifically discuss Sebree Bank, based on five ranking criteria, similar Nepheloid Zone communities were given low ranking at other topographic features.

Big and Small Adam Banks are also low-relief features subject to sedimentation. Rezak and Bright (1981) categorized these features as banks where protection is not recommended. Although the banks may contain the Antipatharian Zone, this designation is speculative (Rezak et al., 1983). Big and Small Adam Banks were given the lowest ratings of those topographic features discussed by Rezak and Bright (1981), based on their criterion for environmental priority rankings.

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* was first reported in 2002 in the East Flower Garden Bank, but it is also reported to live on oil and gas platforms in the northern Gulf of

Mexico, including one nearby the East Flower Garden Bank (Fenner and Banks, 2004; Sammarco et al., 2004; Hickerson et al., 2008). The lionfish has been 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 has also recently been reported in the southern Gulf of Mexico (Aguilar-Perera and Tuz-Sulub, 2010). Specific sitings were noted at Sonnier Bank and at several oil and gas platforms in the CPA (USDOI, GS, 2010b). The first reports of the lionfish in the WPA occurred on July 20 and July 27, 2011. The lionfish was first observed at West Flower Garden Bank followed by Stetson Bank in the Flower Gardens Banks National Marine Sanctuary (2011) (USDOI, GS, 2011). This species threatens the ecosystem of the Gulf of Mexico banks because it is a voracious feeder and reproduces very quickly (Flower Garden Banks National Marine Sanctuary, 2011).

Endangered Species

Elkhorn coral (*Acropora palmata*), which was listed as "threatened" in 2006 and is protected under the Endangered Species Act, is a common reef-building species in Caribbean coral reefs (USDOC, NOAA, 2010e). It was discovered at the West Flower Garden Bank in 2001 (Precht et al., 2006). Another colony of this species was discovered at the East Flower Garden Bank in 2005 (Precht et al., 2008). The northward expansion of this species is likely due to increasing water temperatures in the northern Gulf of Mexico (Precht and Aronson, 2004).

Candidate Species

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, 2010e). 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 will be made as to whether each species warrants listing under the ESA or not. If these species are listed, they will receive protection under the ESA.

Habitat Areas of Particular Concern

The NMFS has designated habitat areas of particular concern (HAPC's) within identified essential fish habitat. The HAPC's provide important habitat for federally managed fish species and are areas for conservation priorities. Coral HAPC's, which are only located in the WPA, are the East and West Flower Garden Banks (Dale and Santos, 2006; Gulf of Mexico Fishery Management Council, 2005). Hard-bottom HAPC's in the WPA are the Texas-Louisiana shelf break features and include Stetson Bank, 29 Fathom Bank, MacNeil Bank, Rankin Bank, and Bright Bank (Dale and Santos, 2006; Gulf of Mexico Fishery Management Council, 2005).

Hurricane Impacts on Western Planning Area 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 the monitoring of features, including the Flower Garden Banks and Stetson Bank, before and after hurricanes. Long-term monitoring data from the Flower Garden Banks indicated that recovery observed after hurricane-induced damage agrees with historical surveys, indicating that this community is fairly resilient and stable over long periods of time (Gittings, 1998). Recovery trends have also been observed at these banks in surveys conducted 1-3 years after damage from Hurricane Rita (September 23, 2005) (Robbart et al., 2009; Precht et al., 2006 and 2008; Hickerson, 2008; DeBose et al., 2008).

Hurricane Ike passed over the East and West Flower Garden Banks on September 12, 2008. Similar destruction to the coral and sponge colonies was observed after Hurricane Ike as was observed after Hurricane Rita, except coral bleaching was not experienced with Hurricane Ike (Hickerson, 2008). Sponges were sheared, coral was broken and toppled, and heavy sediment scouring and deposition occurred. Damage was recorded in the same areas as occurred after Hurricane Rita, although it should be noted that substantial recovery had occurred by August 2008 at these sites (Hickerson, 2008). It is anticipated, based on the observed recovery of communities between 2005 and 2008, that similar recovery should occur following Hurricane Ike.

Baseline Conditions Following the *Deepwater Horizon* Event

It is highly unlikely that the topographic features of the WPA have been impacted by the DWH event because of their distance from the oil spill. As a result of the distance of the topographic features from the location of the DWH event, it is anticipated that there will be no change in existing baseline conditions. The benthic communities on 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), did not indicate oil in the surface waters of the WPA (USDOC, NOAA, 2011b). The oil was concentrated in the CPA and the oil that migrated west in the CPA was primarily observed close to Louisiana's Gulf Coast. The Macondo well was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary. Data collected by the Operational Science Advisory Team revealed that oil from the spill was concentrated near the source indicating that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). 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 benthic communities in the WPA are not anticipated to be impacted by the localized report of oil.

No visual observations of oil have been reported in or near the Flower Garden Banks National Marine Sanctuary as a result of the DWH event (Schmahl, 2011). Semipermeable membrane devices were deployed and sediment samples were collected at the East and West Flower Garden Banks, Stetson Bank, and Sonnier Bank between July 2010 and March 2011 to detect hydrocarbons in the water and sediment near these banks. The data were collected as part of the NRDA process, and analysis of the samples has not yet been released (Schmahl, 2011)

An early response "quick look" cruise conducted by NOAA and Harbor Branch Oceanographic Institute at the Flower Garden Banks from May 16-21, 2010, also did not report the presence of oil in the Sanctuary (Hickerson et al., 2010). Biological samples were collected and photographs were taken during the cruise. As no observations of oil or oil-related impacts were discussed in the cruise report, it may be inferred that none were observed at the Flower Garden Banks in May 2010 during the cruise.

The NOAA R/V *Thomas Jefferson* conducted a 13-day mission to collect baseline data in portions of the Gulf of Mexico. The cruise, which lasted from June 15-27, 2010, collected water samples to determine baseline conditions at the Flower Garden Banks National Marine Sanctuary prior to any possible impacts as a result of the oil spill (USDOC, NOAA, 2010g). Also, NOAA is currently monitoring for hydrocarbon substances using semipermeable membrane devices that have been placed on several banks in the Flower Garden Banks National Marine Sanctuary to determine if oil reaches any of the banks (USDOC, NOAA, 2010e).

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 water samples collected from deep water (>200-m [656-ft] depth) 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) and moving southwest along those depth contours (OSAT, 2010), which is deeper than the topographic features. No sediment samples were collected offshore (>3 nmi offshore to the 200-m [656-ft] depth contour), but seven sediment samples were 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 WPA, 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 do occur in the WPA, in spite of the remote distance from the DWH, they will 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 the numerous natural seeps in the WPA that are constantly releasing oil into the water (MacDonald, 2002).

Based on the distance of the WPA from the Macondo well and the fact that the westernmost extent of the sheen from the DWH event remained east of the WPA, it is not expected that any new information released from research cruises would impact BOEM's analysis of topographic features in the WPA or the potential impacts from a WPA proposed action on these features. This information, therefore, is not essential to a reasoned choice among the alternatives analyzed in this EIS.

4.1.1.6.2. 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 WPA, are listed and described in **Chapter 4.1.1.6.1**.

The potential routine impact-producing factors on topographic features of the WPA 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 4.1.1.6.3**. These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features in the WPA.

A Topographic Features Stipulation similar to the one described in **Chapter 2.3.1.3.1** 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 WPA proposed action. The impact analysis of routine activities associated with a WPA proposed action presented here includes the proposed Topographic Features Stipulation. As noted in **Chapter 2.3.1.3.1**, 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, sponges, and other benthic organisms; the anchor chain or cable may drag across and shear organisms off the substrate (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 for exploratory wells [900 metric tons of drilling fluid and 1,100 metric tons of cuttings] and slightly lower discharges for development wells) (Neff, 2005), potential impacts on biological resources of topographic features should be expressly considered 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-Mile Zone, 3-Mile Zone, 4-Mile Zone, and 1,000-Meter 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 general 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, 4.1.1.2.1.2, and 4.1.1.2.2.2** 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.

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).

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 2009b). 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; at 96 m (315 ft) from the release point, Shinn et al. (1980) measured a plume as only a few milligrams/liter above background suspended sediment concentrations.

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, 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 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.

It is not anticipated that muds drifting in the water column will 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 indicate suspended solids 96 m (315 ft) from the discharge point are far below concentrations that cause coral mortality (Shinn et al., 1980), corals should be adequately distanced for protection from the effects of drilling turbidity.

Due to the proposed Topographic Features Stipulation, impacts measured as a result of drilling operations will be minimal in comparison to impacts without the proposed Topographic Features Stipulation. Wells drilled in lease blocks containing topographic features will be required to shunt cuttings to within 10 m (33 ft) of the seafloor. Bottom shunting will 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 distance from drilling operations and 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 4.1.1.2.2.2**.

Produced waters are rapidly diluted and impacts are generally only observed within close 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 ng/L (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 amd 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 the crests of features are generally 15 m (49 ft) or more below the sea surface (Burns et al., 1999; Rezak et al., 1995).

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 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'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 amd Heyward, 2000). The WAF's, however, are 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 affect 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), the influence of currents around topographic features (Rezak et al., 1983; McGrail, 1982), and the 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, will 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). Light may also be blocked, resulting in 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 anerobic 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 massive forms of 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, such as those at the Flower Garden Banks, 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 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-kilogram (kg) (298-pound [lb]) charges in open water incurred a 5-percent mortality rate. Crabs distanced 8 m (26 ft) away from the explosion of 14-kg (31-lb) charges in open water had a 90-percent mortality rate. Few crabs died when the charges were detonated 46 m (151 ft) away. 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 *Programmatic Environmental Assessment for Structural Removal Activities* (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] per well piling and per conductor jacket) and because BSEE regulations require charges to be detonated 5 m (15 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 will 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 epifaunal organisms attached to the platform will die once the platform is removed. However, the seafloor habitat will 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 will remain part of the benthic habitat. The diversity of the community will not change, and associated finfish species will continue to graze on the encrusting organisms. The community will remain an active artificial reef. However, the plugging of wells and other reef-in-place decommissioning activities will still impact benthic communities as discussed above, since all the steps for removal, except final extraction from the water, would still occur.

Proposed Action Analysis

All of the 22 topographic features (shelf edge banks, low-relief banks, and south Texas banks) in the WPA are found in waters less than 200 m (656 ft) deep. They represent a small fraction of the WPA. 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 discharges, produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in **Chapter 4.1.1.6.3**.

For a WPA proposed action, 23-38 exploration/delineation and 30-49 development wells are projected for offshore Subarea W0-60 (coastline to 60 m [197 ft] of water). There are an additional 7-12 exploration/delineation wells and 11-17 development wells proposed between 60 and 200 m (197 and 656 ft) (out to the boundary of the continental shelf) (**Table 3-2**). 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 2.3.1.3.1** for specifics). This procedure would essentially prevent the threat of drilling effluents reaching the biota of a topographic feature (Bright and Rezak, 1978). 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 discharges or produced waters do reach any topographic features, concentrations of these anthropogenic influences would be diluted substantially from their initial concentration, and effects would be minimal.

For a WPA proposed action, 10-17 production structures are projected in offshore Subarea W0-60 (coastline to 60 m [197 ft] of water) and 1-2 production structures are predicted for Subarea W60-200 (60-200 m [197-656 ft] of water). From 7 to 12 structure removals using explosives are projected for the Subarea W0-60 and 1 is projected in Subarea W60-200 (**Table 3-2**). 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 WPA 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 WPA could be adversely impacted by oil and gas activities resulting from a WPA 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 WPA topographic features.

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 and not followed up by mitigating measures. 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 of 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. Operational 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 operational effluents 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 WPA proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features (Fucik et al., 1984; Rogers and Garrison, 2001).

4.1.1.6.3. Impacts of Accidental Events

The topographic features of the WPA that sustain sensitive offshore habitats are listed and described in **Chapter 4.1.1.6.1**. See **Chapter 2.3.1.3.1** for a complete description and discussion of the proposed Topographic Features Stipulation. Although the lease stipulation was created to protect topographic features from routine impacts of drilling and production, they also protect topographic features from accidental impacts by distancing wells from the features. Clarification on how the proposed Topographic Features Stipulation applies to operators is detailed in this Agency's NTL 2009-G39 (USDOI, MMS, 2009a).

Disturbances resulting from a WPA 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 WPA.

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 will 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 (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. 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 reducing impact to the organisms on the seafloor below. 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 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 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 clarifies how the proposed Topographic Features Stipulation applies to operators, 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 proposed Topographic Features Stipulation requires that drilling not occur within 152 m (500 ft) of a No Activity Zone of a topographic feature. Details on this requirement are described in NTL 2009-G39. This additional recommendation is based on essential fish habitat, and construction within the essential fish habitat would require project specific consultation with NOAA.

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 benthic communities. 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 4.1.1.6.1**). 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*, *Siderastraea 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 10-20 m (33-66 ft) (Lange, 1985; McAuliffe et al., 1975; McAuliffe et al., 1981a; Tkalich and Chan, 2002). Therefore, the depth of topographic 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 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 the distance provided from No Activity Zone and the NTL 2009-G39 recommendation of the additional 152-m (500-ft) buffer beyond the No Activity Zone, a proposed stipulation that is written into the lease sale. The distance allows for several physical and biological changes to occur to the oil before it reaches sensitive benthic organisms. Oil will become diluted 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 will be (Vandermeulen, 1982; Tkalich and Chan, 2002). Microbial degradation of the oil occurs 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 banks will be physically protected because currents move around the topographic features, which may help sweep the subsea oil clear of the banks (Bright and Rezak, 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 will 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 reach 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). Direct oil contact (or dispersed oil contact) may have resulted in damage to a deepwater (1,400 m; 4,593 ft) coral (gorgonian) community 11 km (7 mi) to the southwest of the DWH well; thie community was located in the direction of travel of a 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). Many of the gorgonians in the affected area were dead or dying, had areas bare of tissue, were covered with brown material, and had tissue falling off their skeletons (Fisher, 2010a and 2011a). A colony of hard coral, *Madrepora* sp., (400 m [1,312 ft] away) did not appear to be as severely impacted, but there was some brown material on the coral, along with sloughing tissue and abundant mucus (Fisher, 2010a and 2011a; USDOI, BOEMRE, 2010j). Two repeat visits to the gorgonian site in December 2010 and March 2011 revealed that the impacted coral did not appear to be improving and hydrozoans were beginning to grow on the areas where corals died, which could introduce competition and secondary infection into the area (Fisher, 2011a).

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 impacts 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 (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 been reported for other reef-building corals exposed to sublethal concentrations of oil as well (Peters et al., 1981). Laboratory experiments on chronic oil pollution have also shown reduced numbers of female gonads per polyp in *Stylophora pistillata* (Rinkevich and Loya, 1979).

Gametes of mass spawning coral species, however, may be exposed to oil on the water's surface because the gametes are buoyant (Haapkylä et al., 2007; Negri and Heyward, 2000). Larvae may experience the same exposure while in the water column. 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). The inhibition of larval metamorphosis was also reported for the WAF of 0.0824 ppm total hydrocarbons (Negri and Heyward, 2000). A WAF, however, is based on static experimental equilibrium conditions, which could not happen in the Gulf of Mexico, and therefore, such exposures are unlikely. The experimental value can be considered a "worst-case scenario" if the entire Gulf were to come in equilibrium with oil inputs.

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 (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*, *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). 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 topographic features. This deepwater coral community appears to have been impacted by contact with oil from the DWH (USDOI, BOEMRE, 2010j). The circumstances of the deepwater coral exposure were not typical because the release of oil was 1,500 m (4,922 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 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 [3,609-4,265 ft]) thought to be bounded by stratified density layers of water, allowing it to remain at depth instead of dispersing into the water column, and it eventually contacted 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). So, 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 less than 20 m (66 ft) above the seafloor. The reef organisms of the topographic features live above the turbid waters and, therefore, would probably not be contacted by a stratified oil layer. 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 South Texas 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.

In addition, 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, among other things, focus OCS activities at specified distances from the topographic features, thereby increasing the distance between the topographic features and an 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, is not recommended 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, but 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.

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. Dispersants can increase the potential for oil to contact corals because they increase the incorporation of oil into water (Haapkylä et al., 2007). 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). 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 subsea oil plume ranged through a 200-m (656-ft) depth range, it was thought to be bounded by stratified density layers of water. Stratification is also found on the continental shelf. Studies of the nepheloid layer (a layer of turbid water) showed that stratified water normally restricts the nepheloid layer to near 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 and 1985; 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; Knap et al., 1985), 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 and 1985). 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).

Dispersed oil may impact coral larvae. The gametes of mass spawning coral may be exposed to dispersed surface oil because the gametes are buoyant and rise to the water's surface (Haapkylä et al., 2007; Negri and Heyward, 2000). Larvae may also experience the same exposure while in the water column. The minimum concentration of the WAF of total hydrocarbons of dispersed crude oil that inhibited both fertilization and metamorphosis of the larvae of *Acropora millepora* was measured at 0.0325 ppm (Negri and Heyward, 2000). One must be careful in using WAF to determine toxicity in an open system, however, because it is based on a closed system reaching equilibrium with a contaminant, something that will not happen in the Gulf of Mexico. Therefore, this number may be not applicable for the GOM and could be considered a "worst-case scenario" if the entire Gulf were to come in equilibrium with oil inputs.

Historical studies indicated 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 use of 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 several studies (McAuliffe, 1987; Shigenaka, 2001).

Although dispersed oil may be toxic to corals during 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; Gittings et al., 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 adsorbed 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 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 would have less light penetrating to depth, which may result in reduced photosynthesis by the symbiotic zooxanthellae that live in 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 BOEM’s proposed stipulation (guidance provided 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 BOEM’s proposed stipulation. 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 No Activity Zone to prevent adverse effects from nearby drilling on topographic features. This Agency has created a No Activity Zone 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 describes the regulations of the Topographic Features Stipulation that applies to operators where drilling would 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.

Although the 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, or 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 WPA 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 WPA proposed action ranges from 234 to 404 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 WPA proposed action, <1 spill of this volume in expected to occur as a result of a WPA 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 WPA proposed action anywhere between the shoreline and 300-m (984-ft) depth contour in the WPA, 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 the Texas West polygon, the OSRA model estimated probabilities of 3-5 percent and 5-8 percent after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**). For the Texas East polygon, the OSRA model estimated probabilities of 8-14 percent and 9-15 percent after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**).

Probabilities of oil contacting the surface water above HAPC's in the WPA, including the East Flower Garden Bank, West Flower Garden Bank, and Stetson 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 10-day spill originating from a WPA proposed action and contacting the surface waters of the East and West Flower Garden Banks was <0.5-1 percent, and it was <0.5 percent for Stetson Bank.

All of the topographic features in the WPA are found in water depths less than 200 m (656 ft). They represent a small fraction of the continental shelf area in the WPA. 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 2.3.1.3.1.)** 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. The East Flower Garden Bank rises to within 15 m (49 ft) of the sea surface, and the West Flower Garden Bank rises to within 18 m (59 ft). Any oil that might be driven to 15 m (49 ft) or deeper would probably be at concentrations low enough to reduce 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.

Oil adsorbed to sediment particles 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 sediment particles 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 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 sediment particles would also be at low concentrations by the time the topographic features were reached, also likely resulting in primarily 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 WPA could be damaged by oil and gas activities resulting from a WPA 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 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 WPA proposed action are discussed in **Chapter 4.1.1.6.2**.

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). Dispersants should not be applied near sensitive areas such as coral communities according to NOAA Policy (Gittings, 2006). Although not specifically regulated by BOEM‘s proposed stipulation, the dispersants' possible use is physically distanced by buffer zones created by BOEM stipulations. Dispersants could be applied at a spill close to sensitive features if the buffer zone between petroleum-producing activity and a sensitive feature is not enforced through stipulations. Indeed, disturbances, including oil spills and blowouts, would 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. Therefore, in the absence of the proposed Topographic Features Stipulation, a WPA proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features in the event of a spill.

4.1.1.6.4. Cumulative Impacts

The proposed Topographic Features Stipulation is assumed to be in effect for this cumulative analysis. 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 WPA 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. The continued application of the proposed Topographic Features Stipulation precludes anchoring on topographic features by oil- and gas-related operations. 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., 1985). The proposed Topographic Features Stipulation 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 features (USDOI, MMS, 2009a).

The USEPA, through its NPDES discharge permit, also enacts further mitigating measures on discharges. As noted above under routine events of a WPA proposed action, 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 be restricted to small areas, with little effect on the biota.

The proposed Topographic Features Stipulation protects 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). The shunting of drilling muds and cutting 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 where 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 can be physically removed by currents that can shed the mucus-trapped particles from the coral (Shinn et al., 1980; Hudson and Robbin, 1980).

With the inclusion of the proposed Topographic Features Stipulation, no discharges of effluents, including produced water, would take place within the No Activity Zone. Drill cuttings in areas around the No Activity Zone will be shunted to within 10 m (33 ft) of the seabed. This procedure, combined with USEPA's discharge regulations and permits, should eliminate the threat of discharges reaching and affecting the biota of a topographic high. The impacts that these discharges could cause would be primarily sublethal damages that could lead to a possible disruption or impairment of a few elements at a local scale, but no 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 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). The limited depth of mixing 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 will 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 a coral-covered area in lethal concentrations, the recovery of this area could take in excess of 10 years (Fucik et al., 1984).

The cumulative impact of the DWH event on the WPA, if any, is anticipated to be small. The Macondo well was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, which is to the east of the WPA boundary. Data collected by the Operational Science Advisory Team indicate that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). No visual observations of oil have been reported in or near the Flower Garden Banks National Marine Sanctuary as a result of the DWH event (Schmahl, 2011). Based on the distance of the WPA from the Macondo well and the fact that the westernmost extent of the sheen from the DWH event remained east of the WPA, it is not expected that any information released as part of the NRDA process following the DWH event would impact BOEM’s analysis of topographic features in the WPA or the potential incremental impact on these features. This information, therefore, is not essential to a reasoned choice among the alternatives analyzed in this EIS.

Platforms will be removed from the OCS Program each year; some may be in the vicinity of topographic features (**Table 3-2**). 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. The Flower Garden Banks National Marine Sanctuary allows conventional hook and line fishing within the boundaries of the Sanctuary, which includes Stetson Bank (USDOC, NOAA, 2010h). Also, the Flower Garden Banks and 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 Flower Garden Banks National Marine Sanctuary prohibits all anchoring within its boundaries and has installed numerous mooring buoys at the East and West Flower Garden Banks and Stetson Bank to support recreational activities (USDOC, NOAA, 2010h).

The use of explosives in treasure-hunting operations has become a concern on topographic features; several large holes and serious damage has occurred on Bright Bank in the CPA, which has resulted in the loss of coral cover (Schmahl and Hickerson, 2006). The recovery from such destructive activity may take in excess of 10 years and would depend on the type and extent of damage incurred by individual structures (Fucik et al., 1984; Rogers and Garrison, 2001). This activity is not governed by BOEM or NOAA and could impact topographic features in the WPA.

Impacts from natural occurrences such as hurricanes occasionally result in damage to the biota of the topographic features. When Hurricane Rita passed 95 km (60 mi) east of the East Flower Garden Bank, coral colonies were toppled, sponges and fields of finger coral (*Madracis mirabilis*) were broken, coral tissues were damaged by suspended sand and rocks, and large-scale shifts occurred in sand patches (Hickerson et al., 2008; Hickerson and Schmahl, 2007; Robbart et al., 2009). Hurricane Katrina may have caused serious damage on Sonnier Bank farther east. 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 and beyond regulation abilities.

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. Collecting is prohibited at the Flower Garden Banks National Marine Sanctuary (USDOC, NOAA, 2010h). 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. 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 features. 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. 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 corals and much of the other fully developed biota. In the event that oil from a subsurface spill reached an area containing hermatypic coral cover (e.g., the Flower Garden Banks and Stetson Bank) 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 WPA 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.

4.1.1.7. Sargassum Communities

4.1.1.7.1. 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 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, 1987a; 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. Recent findings suggest that *Sargassum* provides critical habitat that may have an influence on the recruitment success of several species (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 include 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, 1987a; 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, 1987a; 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. They believed that an increase in petroleum pollution and associated toxic effects in the GOM may have contributed to the declining macrophyte populations. *Sargassum* has been noted to have higher levels of toxins than in surrounding water samples in polluted areas. Oceanographic processes that concentrate *Sargassum* into mats and rafts may also concentrate surface oil slicks.

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.

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* oil 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. The BOEM does not have the ability to obtain this information in the timeline contemplated by this EIS, regardless of costs. 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.

4.1.1.7.2. Impacts of Routine Events

Proposed Action Analysis

Impact-producing factors associated with routine events for a WPA 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. Waterbased 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 2009b).

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 WPA proposed action is estimated to result in a total of 130-210 wells in the WPA (**Table 3-2**). While this may seem like a large number of wells, they would affect only a very small portion of the 115,645 km^2 (44,651 mi^2) of the WPA. 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 2009b). 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 WPA 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 WPA 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 found throughout the GOM and northwest Atlantic. Considering its ubiquitous distribution and occurrence in the upper water column near the sea surface, it would be contacted by routine discharges from oil and gas operations. All types of discharges including drilling 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 WPA (115,645 km^2 [44,651 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, concentrations of any toxic components would be reduced; therefore, produced-water impacts on *Sargassum* would be minimum. 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 WPA 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.

4.1.1.7.3. Impacts of Accidental Events

Proposed Action Analysis

Impact-producing factors associated with accidental events for a WPA 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 WPA as a result of a proposed action is presented in **Table 3-12**. The possibility of a spill ≥1,000 bbl resulting from a WPA proposed action is estimated to be less than one spill in the 40-year period (2012-2051).

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 seashore. 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 1981b; Knap et al., 1985). With vigorous wave action, the oil can form an emulsion with water that is viscous and persistent.

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 and would begin to flocculate with particulate matter until it becomes heavy enough to sink to the seafloor. 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). As time passes, the oil would begin to adhere to particles in the water column, form clumps, and sink toward the seafloor (ITOPF, 2002; Kingston et al., 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 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 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 anti-foulant 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 WPA (115,645 km^2 [44,651 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 WPA 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 cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community unless a catastrophic spill occurs.

4.1.1.7.4. 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 4.1.1.7.1** 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 2009b). 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 WPA 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 seawater (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., 1992b). 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 impacts that affect the *Sargassum* community. The violent surface turbulence of 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, sargassumfish (*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 are 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. As with hurricanes, loss of *Sargassum* to the coastal environment contributes to cumulative impacts for the overall community in the GOM.

Summary and Conclusion

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. Because of the ephemeral nature of *Sargassum* communities, many activities associated with a WPA 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 WPA proposed action. If such a spill did occur, *Sargassum* in that area is expected to suffer mortality. The incremental contribution of a WPA proposed action to the overall cumulative impacts on *Sargassum* communities that would result from the OCS Program, environmental factors, and non-OCS related user group activities is expected to be minimal.

4.1.1.8. 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 WPA 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 WPA 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 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 WPA 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 WPA 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.

4.1.1.8.1. 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, mucus 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 of 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 WPA 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 GOM. 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 Perdido Canyon, Alaminos Canyon, and Keathley Canyon; the most notable sea-bottom features on the lower slope are in this area.

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. 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. Rowe and Kennicutt (2009) divide deep water into four biological zones: (1) upper slope; (2) mid-slope; (3) lower slope; and (4) abyssal plain. 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 WPA 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 declines 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.

Deepwater Horizon Event

The DWH event released an estimated 4.9 million bbl of oil into the water 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 results 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. Direct effects from the spill are not expected in the WPA due to the long distance from the spill site (480 km; 300 mi).

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 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). 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 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).

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. 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 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.

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. (1981) 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 less than 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 µg L^{-1} (>5 ppm) within the plume.

Joye (2010) reports observation of seafloor conditions that appear to be sedimented oil in the area around the DWH event site (Harris, 2010). The report suggests extensive oil deposition based on the color of the upper sediments in seafloor cores. While this observation may have some merit, lab analyses for verification are pending. The visual appearance and coloration of Joye's cores are similar to typical cores of the seafloor in this area. Underwater currents are directional, making it unlikely that oil would be distributed in all directions around the well site.

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 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 the high flux of hydrocarbons, usually producing mud volcanoes or flows of mud downslope and possible chemosynthetic activity; and (3) pockmarks that likely result from the 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 the 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, 2011b).

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 has 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 million bbl of oil into the water 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 results have been published as of this writing. Descriptions of studies completed or in progress are discussed previously in this section on deepwater environments. Possible impacts to chemosynthetic communities are discussed below.

A recent report documents damage to a deepwater coral community 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 and chemosynthetic communities form structures that protrude up into the water column above the seafloor, making them more susceptible to impacts from a passing oil plume. It is possible that chemosynthetic communities could have been affected by a passing oil plume. Research projects are continuing to investigate these areas to assess the impacts. Chemosynthetic communities that received low quantities of well-dispersed oil undergoing biodegradation likely experienced little negative effect. Exposure may have been similar to normal conditions for these communities or may have caused some fluctuation in health, resulting in slower growth or delayed spawning. Exposures to low 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). Communities exposed to more 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. Other invertebrates associated with chemosynthetic communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure.

4.1.1.8.2. Impacts of Routine Events

Background/Introduction

Considerable mechanical damage could be inflicted upon deepwater chemosynthetic communities by routine OCS drilling activities associated with a WPA 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 WPA 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 (>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 will 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; 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 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 will tie into existing systems or (rarely) bring production directly to shore. Pipelines will 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 will 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; Continental Shelf Associates, Inc. 2004b) with up to 45 cm (18 in) near a well measured in one study (CSA, 2006).

MacDonald et al. (1995) indicates 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 WPA subareas that include waters ≥300 m (984 ft), i.e., offshore Subareas W200-800, W800-1600, W1600-2400, and W>2400 m (**Figure 3-1**). The levels of projected activity in these subareas as a result of a WPA proposed action are shown in **Tables 3-2 and 3-5**. A typical lease sale is expected to result in the following for the relevant subareas: 23-39 exploration wells, 36-55 development wells, and 4 production structures. The OCS Program activities in the WPA up through this 5-Year Program are expected to result in the following for the years 2012-2051: 510-720 exploration wells; 610-910 development wells; and 15-24 production structures.

The NTL 2009-G40 describes BOEM’s 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 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 BSEE 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 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. The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring the avoidance of potential chemosynthetic communities. 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 WPA 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 WPA proposed action would be minimal to none.

4.1.1.8.3. 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 water 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 that the presence of oil would have a 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 in the WPA as a result of a proposed action is presented in **Table 3-12**. The possibility of a spill ≥1,000 bbl resulting from a WPA proposed action is estimated to be less than one spill in the 40-year period (2012-2051). The possibility of oil from a surface spill reaching a 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 on the sea surface or at depth. The dispersed oil would be suspended in the water column and travel with currents. 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 stick 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 in a line 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 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, 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.

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. It requires avoidance of 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.

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 WPA 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. 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 WPA 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 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, will 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.

4.1.1.8.4. 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, 2004a). 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 WPA 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.

One potential significant, large-scale source of impact could be potential efforts of carbon sequestration in the deep sea as a technique to reduce atmospheric carbon dioxide. This concept is still being considered but could have major ramifications. One side of the issue, even beyond the problems of sea-level increase and climate change, includes the serious risk to shallow-water benthic organisms through pH decreases, particularly those with calcium carbonate shells and skeletons (e.g., corals, serpulid worms, bryozoa, calcareous algae, etc.) (Kleypas et al., 1999b; Barry et al., 2005; Shirayama and Thornton, 2005). However, the impacts of even very small excursions of pH and CO_2 in the deep sea could also have serious, even global, deep-sea ecosystem impacts. Kita and Ohsumi (2004) suggest sequestration of anthropogenic CO_2 could help reduce atmospheric CO_2, but they also summarize the potentially substantial biological impact on marine organisms. The issue continues to gain attention with the increased emphasis on climate change. Scientists suggested in the August 2006 issue of the *Proceedings of the National Academy of Sciences* that thousands of years of the Nation's carbon emissions could be stored in undersea sediments along the coasts (Zenz House et al., 2006). A similar plan has been promoted by a private corporation to spread large amounts of nitrogen fertilizer in low-productive tropical waters (Maden and Nevala, 2008). Such a plan needs further thought since nutrients in urban runoff to tropical seas are considered to be a major contributor to the decline of coral reefs. Substantial additional research is needed before any large-scale actions would take place.

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 WPA; these activities will 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 will 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 WPA for the years 2012-2051 are shown in **Table 3-5**. For the WPA deepwater offshore Subareas W200-800, W800-1600, W1600-2400, and W>2400, there are currently an estimated 510-720 exploration and delineation wells, 610-910 development and production wells to be drilled, and 15-24 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 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 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 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, 2010h). Such blowouts are rare and may not release catastrophic quantities of oil. 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. 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). Dispersants reduce 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 15,000 locations in the deep GOM that represent potential hard-bottom habitats. 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 G-40. 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 communities. 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 WPA considered under the cumulative scenario are expected to cause no 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.

The incremental contribution of a WPA 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 will be limited but not completely eliminated by adherence to the guidelines described in NTL 2009-G40.

4.1.1.9. Nonchemosynthetic Deepwater Benthic Communities

4.1.1.9.1. 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 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 the high flux of hydrocarbons, usually producing mud volcanoes or flows of mud downslope and possible chemosynthetic activity; and (3) pockmarks that likely result from the 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 the 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, 2011b).

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 million bbl of oil into the water 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 results have been published as of this writing. Descriptions of studies completed or in progress are discussed in the previous section on chemosynthetic communities (**Chapter 4.1.1.8.1**). Possible impacts to nonchemosynthetic communities are discussed below; however, direct effects from the spill are not expected in the WPA due to the long distance from the spill site (480 km; 300 mi). These would be particularly relevant if a similar event occurred in the WPA.

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 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 4.1.1.8.1**. 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.

There have been no experiments showing the response of deepwater corals to oil exposure. Experiments with shallow tropical 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 a branching species. Tests with shallow tropical gorgonians indicate relatively low toxic effects to the coral, suggesting deepwater gorgonians 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 discernable 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.

4.1.1.9.2. Impacts of Routine Events

Considerable mechanical damage could be inflicted upon sensitive nonchemosynthetic deepwater benthic communities by routine OCS drilling activities associated with a WPA 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 WPA proposed action is presented below.

Anchoring and Structure Emplacement

The greatest potential of 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-deep water (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 will 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 on 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) depth. 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 will tie into existing systems or (rarely) bring production directly to shore. Pipelines will 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 will 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 sea surface are spread across broad areas of the seafloor and are generally distributed in thinner accumulations. A deepwater effects study funded by this Agency 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 are 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 WPA 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 WPA subareas that include water depths ≥300 m (984 ft), i.e., Offshore Subareas W200-800, W800-1600, W1600-2400, and W>2400 m (**Figure 3-1**). The levels of projected activity in these subareas as a result of a WPA proposed action are shown in **Tables 3-2 and 3-5**. A WPA proposed action is expected to result in the following for the relevant subareas: 23-39 exploration wells, 36-55 development wells, and 4 production structures. The Bureau of Ocean Energy Management's OCS Program's activities in the WPA are expected to result in the following for the years 2012-2051: 510-720 exploration wells, 610-910 development wells, and 15-24 production 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 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 are 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 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 sensitive benthic communities. The required buffer distance of separation between potential deepwater live-bottom 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 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 described in 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. The policies described in NTL 2009-G40 greatly reduce the risk of these physical impacts by requiring the avoidance of potential sensitive benthic communities.

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 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 WPA proposed action are expected to cause no damage to the ecological function or biological productivity of deepwater live-bottom communities (deep coral reefs) due to the consistent application of BOEM protection policies as described in NTL 2009-G40. Impacts on sensitive deepwater communities from routine activities associated with a WPA proposed action would be minimal to none.

4.1.1.9.3. 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 deepwater coral 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 water surface are not considered to be a potential source of measurable impacts on nonchemosynthetic 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 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) automatically triggers the evaluation as described in NTL 2009-G40.

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 will 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 from affecting hard-bottom communities located the prescribed distance of more than 610 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 WPA as a result of a WPA proposed action is presented in **Table 3-12**. The possibility of a spill ≥1,000 bbl occurring due to a WPA proposed action is estimated to be less than 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 to 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 coral communities, which should protect them from surface oil.

A catastrophic spill, like the DWH event, could affect nonchemosynthetic 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. 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 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 in a line 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 coral communities. 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 et al., 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.

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 WPA 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. 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 will 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, 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 WPA proposed action would 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. 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, will 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.

4.1.1.9.4. 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 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 the associated deepwater hard bottoms associated with the *Hoplostethus*' preferred habitat. In the GOM, this is most always authigenic carbonate and is 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, 2004a). 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 WPA 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.

One potential significant large-scale source of impact could be potential efforts of carbon sequestration in the deep sea as a technique to reduce atmospheric carbon dioxide. This concept is still being considered but could have major ramifications. One side of the issue, even beyond the problems of sea-level increase and climate change, includes the serious risk to shallow-water benthic organisms (particularly those with calcium carbonate shells and skeletons, e.g., corals, serpulid worms, bryozoa, calcareous algae, etc.) due to pH decreases (Kleypas et al., 1999b; Barry et al., 2005; Shirayama and Thornton, 2005). However, the impacts of even very small excursions of pH and CO_2 in the deep sea could also have serious, even global, deep-sea ecosystem impacts. Kita and Ohsumi (2004) suggest sequestration of anthropogenic CO_2 could help reduce atmospheric CO_2, but they also summarize the potentially substantial biological impact on marine organisms. The issue continues to gain attention with the increased emphasis on climate change. Scientists suggested in the August 2006 issue of the *Proceedings of the National Academy of Sciences* that thousands of years of the Nation's carbon emissions could be stored in undersea sediments along the coasts (Zenz House et al., 2006). A similar plan has been promoted by a private corporation to spread large amounts of nitrogen fertilizer in low productive tropical waters (Maden and Nevala, 2008). Such a plan needs further thought since nutrients in urban runoff to tropical seas are considered to be a major contributor to the decline of coral reefs. Substantial additional research is needed before any large-scale actions would take place.

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 will occur on discoveries throughout the entire depth range of the WPA; these activities will 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 will 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 WPA for the years 2012-2051 are shown in **Tables 3-2 and 3-5**. Deepwater nonchemosynthetic communities occur in waters ≥300 m (984 ft), which would include the WPA deepwater offshore Subareas W200-800, W800-1600, W1600-2400, and W>2400 (**Figure 3-1**). A WPA proposed action is estimated to result in 23-39 exploration wells, 36-55 development wells, and 4 production structures in these subareas. For all WPA proposed actions in this 5-Year Program, there are currently an estimated 510-720 exploration and delineation wells and 610-910 development wells to be drilled and 15-24 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 that was 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 policies 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 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 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). 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 15,000 locations in the deep GOM that represent potential hard-bottom habitats. 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 guidelines 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 will 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 because of the application of the avoidance criteria described in NTL 2009-G40. 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. Guidance provided in NTL 2009-G40 describes required surveys and avoidance prior to drilling or pipeline installation and will 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 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. Region-wide 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 WPA considered under the cumulative scenario are expected to cause no 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.

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 WPA 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 will be limited but not completely eliminated by adherence to the guidelines described in NTL 2009-G40.

4.1.1.10. Soft Bottoms

4.1.1.10.1. Description of the Affected Environment

The seafloor on the continental shelf in the Gulf of Mexico consists primarily of muddy to sandy sediments. Sediments of the western shelf are a mixture of sand, silt, and clay. Quartz sand is present in nearshore waters off Galveston and Port Arthur and offshore of Corpus Christi south to Brownsville, Texas, which changes to silt and clay offshore (Ellwood et al., 2006; Balsam and Beeson, 2003). The South Texas OCS is primarily fine sandy sediment on the inner shelf and fines toward the outer shelf to silts and clays (Behrens et al., 1980; Rabalais, 1990). The remainder of this shelf is comprised of terrigenous silt and clay (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 et al., 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 et al., 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 South Texas OCS revealed that continental shelf benthic habitats can be described primarily on the basis of sediment texture and water depth (Parker et al., 1975; Powell et al., 1980; Rabalais, 1990). 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 (Rhodes, 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).

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 ft) 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 ft) 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*.

A study conducted by Texas A&M and Rice University on the Texas OCS identified benthic infaunal and epifanual invertebrates common to the region. Infaunal organisms that were very common along the shelf included polycheates (*Paraprionospio pinnata* and *Nereis* sp.) and the amphipod, *Ampelisca agassiz* (Parker et al., 1975). Less common species encountered were the polychaetes *Armandia maculata*, *Mediomastus californiensis*, *Tharyx setigera*, *Cossura delta*, and *Ninoe nigripes*. Infaunal species appeared to be influenced by sediment grain size. Species numbers and abundance decreased with increasing distance from shore as the sand component of the sediment decreased and fine material increased with distance from shore (Parker et al., 1975).

Ubiquitous epifauna include shrimp (*Solenocera vioscai*, *Penaeus aztecus*, *Trachypenaeus similis*, and *Sicyonia dorsalis*) and the lesser blue crab (*Callinectes similis*) (Parker et al., 1975). Less common species that were collected include the paper scallop (*Amusium papyraceus*), mantis shrimp (*Squilla chydea*), deepwater rose shrimp (*Parapenaeus longirostris*), longspine swimming crab (*Portunus spinicarpus*) two-spined star fish (*Astropecten duplicates*), and sand dollar (*Brissiopsis alta*). Epifauna did not appear to be limited by sediment grain size, although some species were limited by water depth (Parker et al., 1975).

A 2-year program sponsored by the Bureau of Land Management included studies of the benthic communities on the South Texas OCS (Flint and Rabalais, 1980; Rabalais, 1990). Research was conducted between Pass Cavallo and Matagorda Bay Complex and the U.S.-Mexico border (Rabalais, 1990). These studies revealed that the South Texas OCS is primarily fine sandy sediment on the inner shelf and fines toward the outer shelf to silts and clays (Behrens et al., 1980; Rabalais, 1990). There are fewer hard-bottom features on the South Texas OCS than other portions of the northern Gulf of Mexico, and coarse sediments are associated with ancestral deltas and wave action (Behrens et al., 1980; Rabalais, 1990).

Polychaete worms, which are deposit feeders that feed on the fine sediments, dominate the benthic community throughout the entire shelf (Powell et al., 1980). Sediment grain size was the main determining factor in the benthic communities offshore (Rabalais, 1990). The number of species, organism diversity, and species diversity are greatest nearshore and decrease offshore. However, a few opportunistic species dominate inshore communities, while populations are more evenly distributed father offshore (Powell et al., 1980). This is because the inner shelf is more subject to disturbance than the outer shelf, which is more stable. Nematodes heavily dominated the meiofauna and were most abundant on the southern nearshore shelf (Rabalais, 1990).

The epifaunal species found on the Texas OCS do not show trends as infaunal species do because they are mobile and move throughout the shelf (Powell et al., 1980). Shallow-water communities, which are dominated by mobile decapods, however, do have seasonal population changes. The outer shelf has a high number of species but a low abundance of organisms (Powell et al., 1980).

Non-OCS Oil and Gas Program Threats to Benthic Communities

The benthic communities are threatened by two natural environmental perturbations that occur on the Texas-Louisiana continental shelf: hypoxic to anoxic bottom conditions and tropical storms. Hypoxic conditions occur annually with inconsistent intensities and ranges (Rabalais et al., 2002a). On average, one tropical storm of varying intensity occurs on the Texas-Louisiana continental shelf every 4 years (Stone, 2001).

The Gulf of Mexico hypoxic zone is a band that stretches along the Texas-Louisiana 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. 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 WPA 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).

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., 2002a). 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 not pristine and that there are 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

It is highly unlikely that the soft-bottom benthic communities of the WPA were impacted by the DWH event because of their distance from the blowout. The Macondo well was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary. 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.

Data collected by the Operational Science Advisory Team indicate that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). Very few sediment samples that were collected during and after the DWH event exceeded USEPA aquatic life benchmarks (concentration for potential adverse affects) for PAH concentrations (OSAT, 2010). Of the 388 sediment 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 zone (>200-m; 656-ft depth), only 7 sediment samples that tested positive as Mississippi Canyon Block 252 oil exceeded USEPA aquatic life benchmarks, all of which were collected in deep water in the CPA (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).

Oil was detected in the CPA in a subsurface plume between 1,100 and 1,300 m (3,609 and 4,265 ft) deep and was moving southwest along those depth contours; however, 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). Therefore, benthic organisms in the WPA, including those emergent in the water column, greater than 70 km (43 mi) from the well should not have been exposed to lethal concentrations of oil. 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 in the WPA.

If any impacts to soft-bottom benthic communities in the WPA do occur, they will 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. Although it is highly unlikely that the benthic communities of WPA were exposed to oil with Mississippi Canyon Block 252 origin, discussions of possible impacts as a result of exposure are included in this section because there is no data to indicate conclusive evidence that exposure did or will not occur. This information will likely be developed through the NRDA process. It may be years before this information becomes available, and certainly not within the timeframe of this EIS process. Although this information may be relevant to reasonably foreseeable adverse effects on soft bottoms in the WPA, this information remains incomplete or unavailable at this time, regardless of the costs that would otherwise be necessary to obtain this information. What credible scientific information is available was applied using accepted methodologies. Regardless, complete data are not essential to a reasoned choice among the alternatives because of the distance of the WPA from the most western extent of the sheen and plume from the Macondo well (making any impacts extremely remote), and because of the fact that, even if there were impacts, soft bottoms and their associated species regenerate quickly.

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.

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, and it is believed to have been limited to the CPA and farther east. Although approximately 4.9 million barrels of oil were released into the Gulf waters, not all of that oil reached the seafloor. As of November 2010, it is estimated that 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).

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 decrease with distance from the source. The modes of transport to the seafloor discussed below are anticipated to only deliver a fraction of oil to the seafloor in comparison to what was released from the well and to result in decreasing concentrations of oil 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. However, concentrations of oil from the DWH event in sediments, at the sediment/water interface, and in the water column in the WPA are expected to be extremely low, or not present at all, due to the distance from the blowout.

Sediment Water Interface Exposure

Although a portion of the oil that was released from the well rose to the sea surface and 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 less than 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 1,100-1,400 m (3,609-4,593 ft) below the sea surface where the subsea plume occurred, however, was 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. 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). Many of the gorgonians in the affected area were dying, had areas bare of tissue, were covered with brown material, and had tissue falling off their skeletons (Fisher, 2010a and 2011a). A colony of hard coral, *Madrepora* sp., (400 m; 1,312 ft away) did not appear to be as severely impacted, but there was some brown material on the coral along with sloughing tissue and abundant mucus (Fisher, 2010a and 2011a; USDOI, BOEMRE, 2010j). Two repeat visits to the gorgonian site in December 2010 and March 2011 revealed that the impacted coral did not appear to be improving, and hydrozoans were beginning to grow on the areas where corals died, which could introduce competition and secondary infection into the area (Fisher, 2011a).

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 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 and that 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. Dispersed oil may also come in contact with benthic organisms that move into the water column or at the sediment/water interface. However, 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.

Due to the transient nature of the plume, it may not be possible to determine the concentrations of oil or dispersant to which the deep-sea corals were exposed or for how long they were exposed. The corals were, however, within the 70-km (43-mi) radius where water samples exceeded the USEPA aquatic life benchmarks (OSAT, 2010). But, based on time sequences of sediment and water samples collected from the Gulf, PAH concentrations in the water no longer exceeded USEPA aquatic life benchmarks and sediments near the gorgonians did not exceed the USEPA benchmarks (OSAT, 2010). Also, because we do not know the behavior of oil dispersing at depth, oil concentrations in the dispersed plume may have been higher at times than what was measured in samples. Field studies on dispersants have indicated that dispersed surface oil may be between 20 ppm and 40-50 ppm between 1 and 5 m (3 and 16 ft) from the water's surface (McAuliffe et al. 1981a; Lewis and Aurand, 1997). It is possible that the gorgonians were exposed to concentrations of oil in this range, or higher, which could induce negative impacts in corals (Guzmán and Holst, 1993; Cook and Knap, 1983; Kushmaro et al., 1997; Shafir et al., 2007).

Benthic organisms in the WPA, which is hundreds of kilometers 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 reach the WPA.

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 in the WPA have a much reduced probability of contacting surface oil, but since currents can transport larvae great distances, there is a possibility that some larvae that reach the WPA 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 449 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 and 2011b).

There are some data available on hydrocarbons and dissolved oxygen levels in the water column during the DWH event. 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), far from the bottom-dwelling organisms in the WPA.

The hydrocarbon concentrations measured in the water column 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 the concentrations of oil in the water column were low and that the oil was dispersed. These data points were collected a great distance from the WPA, indicating that hydrocarbon levels in the water column would be even more dispersed in the WPA, decreasing possible exposure levels to mobile benthic organisms. These data suggest that, if any benthic organisms in the WPA were exposed to oil as a result of the DWH event, the concentrations were very low (in the part-per-million range or less). Even larvae exposed to hydrocarbons in the CPA, except for those close to the well, and transported to the WPA in currents 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). 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 levels 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). This is the most recent data released for dissolved oxygen levels on the seafloor at the time of this writing. 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.

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, 2010a). 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 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). Therefore, heavy loads of sedimented oil and possible resultant smothering effects are not expected in the WPA.

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 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 soft-bottom benthic communities in the WPA should not be impacted by concentrations of PAH's in the sediment as a result of the DWH event because they are far removed from the well.

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 be oil spill related (Romano and Landers, 2011). The results of these two studies indicate that impacts to benthos were localized and that 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-m] 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 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, far from the benthic communities in the WPA. 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), but these negative effects were hundreds of kilometers from the WPA.

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). 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. Much of the seafloor likely did not experience any impact from the event. In areas where low levels of oil reached the seafloor, sublethal or immeasurable impacts may occur. Due to the distance of the well from the WPA (and that the resultant plume and sheen remained east of the WPA boundary), it is unlikely that any soft-bottom communities in the WPA were impacted by the spill.

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 volume 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 that entered the Gulf of Mexico as a result of the DWH event. 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 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). 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.

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. For example, only seven sediment samples collected during and after the DWH event in waters greater than 3 nmi (3.5 mi; 5.6 km) from shore revealed exceedances of USEPA aquatic life benchmarks, and these samples were within 3 km (2 mi) of the well (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 would 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 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). Although it is highly unlikely that oil reached the WPA, low-level 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.

Studies to Measure the Impact of the *Deepwater Horizon* Event

Extensive literature, Internet, and database searches have been conducted for results of scientific data on soft-bottom benthic communities following the DWH event. Although many research cruises have occurred, very few reports containing data have been released as of the writing of this EIS. Descriptions of studies completed or in progress are discussed and any results indicated are included in this EIS. Also, because the impacts of the oil spill are not yet known, possible impacts to soft-bottom benthic communities as a result of oil exposure are discussed. However, the long-lasting impacts of this event will take years to determine. As more studies are conducted and more data are released, we will have a better understanding of the breadth of the effects of the DWH event.

The following description outlines a study that was conducted on the soft-bottom benthic community, primarily surrounding the Flower Garden Banks in the WPA. The NOAA R/V *Thomas Jefferson* conducted a 13-day mission on June 15-27, 2010, to collect baseline data in portions of the Gulf of Mexico. The cruise collected water and benthic samples and monitored benthic transects to determine baseline conditions at the Flower Garden Banks National Marine Sanctuary prior to any possible impacts as a result of the oil spill as part of its mission (USDOC, NOAA, 2010i). Also, NOAA is currently monitoring for hydrocarbon substances using semipermeable membrane devices that have been placed in the National Marine Sanctuary to determine if oil reaches any of the banks (USDOC, NOAA, 2010g).

The limited data currently available on the impacts of the DWH event make it difficult to definitively describe any impacts that have occurred or may occur to the benthic communities in the WPA. This information will likely be developed through the NRDA process. It may be years before this information becomes available, and certainly not within the timeframe of this EIS process. Although this information may be relevant to reasonably foreseeable adverse effects on soft bottoms in the WPA, this information remains incomplete or unavailable at this time, regardless of the costs that would otherwise be necessary to obtain this information. What credible scientific information is available was applied using accepted methodologies. Regardless, complete data are not essential to a reasoned choice among alternatives because of the distance of the WPA from the most western extent of the sheen and plume from the Macondo well (making any impacts extremely remote) and the fact that, even if there were impacts, soft bottoms and their associated species regenerate quickly. Once more data are released, we will obtain a better understanding of the measured impacts and possible long-term effects of this event.

4.1.1.10.2. 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 WPA are described in **Chapter 4.1.1.10.1.** 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. Impacts 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 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 115,645 km^2 (44,651 mi^2) of seafloor in the WPA. 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 (115,645 km^2; 44,651 mi^2) as to be insignificant.

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. Increased particle loading may disrupt filter feeders on the seafloor or bury newly settled larvae (Hyland et al., 1994). Discharges, however, do not appear to affect organisms encrusting on the drill platform itself (Monaghan et al., 1980). 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) will 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). Field observations in deep water noted a dispersed patchy distribution of cuttings that was only 20-25 cm (8-10 in) thick (Fechhelm et al., 1999). 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 the 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).

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). Thicker deposits lose oil from the cuttings through exchange with seawater much slower than thinner deposits, lending to a longer period of contamination (Dow et al., 1990). Uncontaminated sediment may be found within centimeters of cuttings deposits (Dow et al., 1990). Any organisms beneath heavy layers of deposited cuttings would be smothered. Because cuttings are distributed unevenly and in patches, the burial of infauna will be localized (CSA, 2004b).

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 that 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 depositions change, they become more inhabitable to benthic organisms.

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 WPA covers 115,645 km^2 (44,651 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 scientifically credible information, applied below, 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). Settlement of pelagic larvae may also be inhibited by elevated levels of drilling mud, as was reported for the red abalone, *Haliotis rufescens* (Raimondi et al., 1997). 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 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). 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 sea floor (Burns et al., 1999). A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in **Chapters 4.1.1.2.1.2 and 4.1.1.2.2.2**.

Produced waters are rapidly diluted and impacts are generally only observed within close 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 were measured 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).

However, there are also particulate components of produced waters that sink and can influence biological activity on the seafloor (Osenberg et al., 1992). The less soluble fractions of the constituents in produced water are those that associate with suspended particles and are 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). The greatest impacts to benthic organisms, therefore, would occur closest to the platform where particles settle.

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. Fouling communities on a production platform in the Gulf of Mexico in the immediate vicinity of a produced-water outfall had low biomass and density, barnacles had low survival rates, and production and recolonization rates were low (Gallaway et al., 1979). The communities near the outfall were also different from those at a distance (Gallaway et al., 1979). 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 & 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. Long-term monitoring in the northern Gulf of Mexico has indicated that chronic, low-level, produced-water discharges do not accumulate to stressful levels in the surrounding environment, therefore reducing the possible impact of discharged heavy hydrocarbons to benthic macrofauna near wells (Sharp and Appan, 1982).

The influence of produced waters on benthic communities surrounding platforms is limited to a few hundred meters at most around the outfall. Rapid dilution of the produced waters decreases the possible toxicity with distance from the outfall. 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, will help to limit the impacts on nearby benthic resources (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 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 (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." 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 will 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 converting in place to artificial reefs would still impact benthic communities as discussed above, since all the steps for removal except final extraction 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 will 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 WPA covers 115,645 km^2 (44,651 mi^2). Operations may affect soft-bottom benthic communities through drilling effluent and produced-water discharges. Of the small area affected, the impacts have been measured to reach only about 100- 500 m (328-1,640 ft) from the production well.

For a WPA proposed action, 23-38 exploration/delineation and 30-49 development wells are projected for offshore Subarea W0-60. There are an additional 7-12 exploration/delineation wells and 11-17 development wells proposed between 60 and 200 m (197 and 656 ft) (out to the boundary of the continental shelf) (**Table 3-2**). 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 (up to 1,000 m [3,280 ft] distance; CSA, 2006). 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 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 2.3.1.3.1** 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 have been measured to 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 will be limited to a few hundred meters from the well.

For a WPA proposed action, 10-17 production structures are projected in offshore Subarea W0-60 and 1-2 production structures are predicted for Subarea W60-200. Between 7 and 12 structure removals using explosives are projected in 0-60 m (0-197 ft) of water, and 1 structure removal is projected in 60-200 m (197-656 ft) of water (**Table 3-2**). 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 WPA (115,645 km^2; 44,651 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 would be are 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).

4.1.1.10.3. 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 WPA are described in **Chapter 4.1.1.10.1.** 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. Because the soft-bottom substrate is ubiquitous throughout the Gulf of Mexico, there are no lease stipulations to avoid these communities. However, other routine practices restrict detrimental activities that could cause undue harm to benthic habitats (e.g., discharge restrictions, debris regulations, NPDES permits)..

Although a low-probability catastrophic spill is not expected, the types or kinds of impacts to soft-bottom communities would likely be the same for a catastrophic or a more typical 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, ejected 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 will be 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 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 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. 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, reducing impact to the organisms on the seafloor below. 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-m (33-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 sedimenting to particles in the water column, benthic communities may be impacted. These scenarios are discussed in later sections.

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). Therefore, soft-bottom benthic communities located in shallow water have the potential to be fouled by oil that is floating on shallow water and 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 would 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 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). Therefore, any dissolved petroleum hydrocarbon constituents that reach larval benthic organisms may cause acute toxicity and other developmental effects to this life stage. The WAF and WSF, however, should be considered “worst-case scenario” values as they are based on a closed system at equilibrium with the contaminant and, due to its size and complexity, the GOM will not reach equilibrium with released oil.

Oil in the water column may impact pelagic eggs and larvae of invertebrates. Toxicity tests indicated that eggs of many species were killed by diesel oil in seawater, and in general, the smaller eggs died earlier (Chia, 1973). Bivalve fertilization and sperm fertility were depressed with exposure to crude oil (Renzoni, 1975). The WSF of crude oil was also highly toxic to gametes, embryos, and larvae of bivalves (Renzoni, 1975). Oil concentrations of 0.1 and 1 ppm caused a decrease in fertilization, development of embryos, survival or larvae, and larval growth in the bivalves *Crasostrea virginica* and *Mulina lateralis* (Renzoni, 1975). Another experiment, however, calculated the LC_{50} for a 6-hour exposure of the gametes, eggs, and larvae of three bivalves (*Crassostrea angulata*, *Crassostrea gigas*, and *Mytilus galloprovincialis*), to be 1,000 ppm oil and 1,000 ppm oil plus dispersant (Renzoni, 1973). Toxicity varies widely among species and oil types.

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 would become 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 would 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 would move in the direction of prevailing currents (S.L. Ross Environmental Research Ltd., 1997) and, although the oil would weather with the distance it travels, low levels of oil transported in subsea plumes would impact benthic communities. 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).

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).

Sedimented Oil (Oil Adsorbed to Sediments)

Smaller suspended oil droplets could be carried to the seafloor as a result of oil droplets adhering to suspended particles in the water column. High concentrations of suspended sediment in the water column may lend to large quantities of sedimented oil (Moore, 1976). 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 near the source (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, and full recovery may take between 2 and 10 years, depending on the severity of the spill and surrounding environmental conditions (Neff, 2005; Kingston, 2002). 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). Communities may remain altered for 2-3 years in sandy environments, and longer in muddy or anoxic sediments where oil degrades slower (Moore, 1976).

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). Contaminated sediment has also been shown to decrease the growth rate of transplanted clams (Dow, 1975). 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 sedimentation process results in the loss of a majority of the more toxic hydrocarbons from the oil (Moore, 1976). 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 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 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 these hypotheses, 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. 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 be measured 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 WPA 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 WPA proposed action ranges from 234 to 404 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 the projected production for a WPA proposed action, <1 spill of this volume in expected to occur as a result of a WPA proposed action. If a large-scale release of oil were to occur, impacts would be more widely spread than that of a small-scale spill. 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. Oil or dispersed oil may cause lethal or sublethal impacts to benthic organisms wherever a plume may contact them.

The probability of surface water oiling occurring as a result of a WPA proposed action anywhere between the shoreline and 300-m (984-ft) depth contour in the WPA was estimated by the Bureau of Ocean Energy Management’s OSRA model for spills ≥1,000 bbl. For the Texas West polygon, the OSRA model estimated probabilities of 3-5% and 5-8% after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**). For the Texas East polygon, the OSRA model estimated probabilities of 8-14% and 9-15% after 10 and 30 days, respectively, that a spill would occur and contact this area (**Figure 3-24**).

A subsurface spill or plume may impact soft-bottom benthic communities. Oil or dispersed oil may cause lethal or sublethal impacts to benthic organisms where a plume may contact them. Impacts may include loss of habitat and biodiversity, contamination of substrate, change in community structure, toxicity to larvae and embryos, and failed reproductive success. Sedimented oil 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 experience lethal impacts as a result of blowouts, surface, and subsurface oil spills and the associated affects. 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.

4.1.1.10.4. Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to soft bottoms of the Gulf of Mexico continental shelf. A WPA proposed action plus those activities related to prior and future OCS lease sales are considered; in this discussion, these are referred to as "OCS-related" factors. Other impacting factors that may occur and adversely affect soft-bottom benthic communities include shipping operations, cable and pipeline laying, bottom trawling, hypoxia (low oxygen levels ≤2 ppm), and storm events.

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 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. 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 damage soft-bottom benthic communities.

There are no BOEM stipulations that require avoidance of soft-bottom benthic communities because they are so ubiquitous throughout the seafloor of the Gulf of Mexico. Most of the 115,645 km^2 (44,651 mi^2) of the WPA are soft mud bottoms; 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.

Severe physical damage may occur to soft-bottom sediments and the associated benthic communities as a result of non-OCS activities. It is assumed infauna associated with soft-bottom sediments of the WPA are well adapted to natural disturbances such as turbidity and storms. However, human disturbance, such as trawling or non-OCS activity oil spills, could cause severe damage to infauna, possibly leading to changes of physical integrity, species diversity, or biological productivity. If such non-OCS-related human disturbances 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 presence of recolonizers nearby, the time of year for reproduction of those colonizers, the currents and water circulation patterns, the extent of possible oiling, 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). 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 have substantial effects on benthic communities, although these impacts are generally temporary as recolonization and immigration from nearby benthic communities should occur within a year.

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 <2 ppm. Such low concentrations are lethal to many benthic organisms and may result in the loss of some benthic populations. Recolonization of devastated 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).

Recreational boating, fishing, and import tankering may have limited impact on soft-bottom communities. Ships anchoring near major shipping fairways of the WPA or recreational fishing boats setting anchor would impact bottom habitats. Anchor placement may crush and eliminate infauna in the footprint of the anchor. Anchoring impacts are localized to the anchor footprint and are temporary, as nearby organisms can repopulate the affected area rapidly.

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). Some studies have indicated that trawled seafloor has reduced species diversity compared with untrawled seafloor (McConnaughey et al., 2000), while others do not show a statistical difference between trawled and untrawled seafloor, although species dominance may shift (Van Dolah et al., 1991). Trawl trails may scour sediment, killing infauna, and epifaunal organisms may be physically removed (Engel and Kvitek, 1998). A review of the use of tickle chains on trawls indicated damage to shallow infauna and surface-dwelling benthic species (Van Dolah et al., 1991). 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).

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). 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).

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." 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 toxic 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 sensitive hard-bottom 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 and 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., 1992a; Holdway, 2002). There have been no reported impacts to marine organisms or sediment contamination beyond 100 m (328 ft) of the produced-water discharge (Neff and Sauer, 1991; Trefry et al., 1995). Therefore, impacts to infauna are anticipated to be localized and only affect a small portion of the entire seafloor of the Gulf of Mexico.

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). Another major impact of the process is pipeline burial. In waters ≤60 m (200 ft), burial of pipelines is required. This involves trenching up to 3.3 m (10.8 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).

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). Surface oil spills and physically dispersed oil released from tankers may impact shallow, nearshore benthic 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 benthic communities. Direct oiling or exposure to water soluble fractions of oil may result 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). Benthic communities farther offshore, in deeper water, 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 (less than 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). A recent report (USDOI, BOEMRE, 2010j) documents damage to a deepwater coral community 7 mi (11 km) southwest of the blowout. Soft bottoms in this area likely received oil also, but they would not be expected to catch as much oil as the benthic communities with greater relief above the seafloor (USDOI, BOEMRE, 2010j).

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 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 has rapidly deteriorated (Hazen et al., 2010).

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 WPA; although, as described above, due to the distance of the WPA from the Macondo well and westernmost extent of the plume and sheen, it does not appear that soft-bottom communities in the WPA were affected. It appears that some impacts have occurred to corals within 7 mi (11 km) of the well in the CPA, 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. Sediment concentrations of hydrocarbons that exceeded USEPA aquatic life benchmarks (concentration for potential adverse affects) occurred in only seven samples collected within 3 km (2 mi) of the DWH well, and concentrations reached background levels at 10 km (6 mi) from the well, indicating a limited radius of severe impact (OSAT, 2010). Therefore, the acute impacts of any large-scale blowout will likely be limited in scale, 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 will be very small compared with the overall size of the seafloor of the WPA (115,645 km^2; 44,651 mi^2) and will not impact the overall infaunal population.

Summary and Conclusion

Non-OCS activities that may occur on soft-bottom benthic substrate include recreational boating and fishing, commercial 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 could crush and smother underlying organisms. 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.

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 WPA 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, however, are small compared with the overall size and ubiquitous composition of the soft-bottom benthic communities in the Gulf of Mexico. 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 throughout the WPA and can recruit quickly from neighboring areas.

4.1.1.11. Marine Mammals

4.1.1.11.1. 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 in the WPA, 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 Fulling, 2004). Because these species are uncommon in the GOM (and by extension the WPA), 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., 1994a; 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, 2007f) 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 the 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 (USDOC, 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 Commission, 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 Commission, 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 Commission, 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, 2007f). 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 post-lease 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.

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 crab, 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., 2011).

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 GOM

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 562 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 (just east of the WPA). More detail on the UME can be found on NMFS's website (USDOC, NMFS, 2011a).

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 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.

Deepwater Horizon Event

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). 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, 2011b). 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.

Marine Mammal Resources in the Western 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 spilled 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's subject-matter experts have used available scientifically credible evidence in this analysis and have applied using accepted scientific methods and approaches..

The BOEM does, however, provide the following analyses relevant to the DWH and UME discussion:

- More species/populations localized in the WPA are unlikely to have been affected by the DWH and UME events. For example, NMFS divides bottlenose dolphins into 37 management stocks, including an eastern coastal (shallow waters to the 20-m [66-ft] isobath; 84º W. longitude to Key West, Florida); a northern coastal (shallow waters to the 20-m [66-ft] isobath; 84º W. longitude to the Mississippi River Delta); a western coastal (shallow water to the 20-m [66-ft] isobath; Mississippi River Delta to Texas/Mexico border); GOM continental shelf; oceanic; and bay, sound, and estuarine (Waring et al., 2011). The stocks most likely to be impacted by the UME and/or the DWH event are the bay, sound, and estuarine stocks (32 of the 37 stocks in the GOM). Animals within these stocks exhibit stable patterns of residency, and data suggest that these stocks would require long periods to repopulate if they were severely depleted (Waring et al., 2011). For the most part, however, animals within these stocks likely maintain their ranges within these areas. The NMFS stranding information collected to date (as discussed and cited earlier), whether from the DWH response effort or through the UME, shows clear concentrations of strandings off central and eastern Louisiana and into western Florida (at least 200 km [124 mi] from the WPA). Only a small subset (4%) of strandings has been documented near the Louisiana/Texas border, which also coincides with the eastern edge of the WPA proposed leased sale area. Based on this, the animals affected by the UME or stranded during or after the DWH event were likely not from bottlenose dolphin stocks found in the WPA.

- Manatees and Bryde's whales, although potentially affected by the DWH event, are not likely found within the WPA and would not be impacted by a WPA proposed action.
- There is the potential for more wide-ranging species (e.g., sperm whales, killer whales, and delphinids) to be found in both the WPA and the areas affected by the DWH event. For example, Jochens et al. (2008) documented sperm whales throughout the northern GOM; however, their distribution was variable depending on oceanographic features. However, the degree that individuals in the areas affected by the DWH spill will also be found and potentially affected by activities under a WPA proposed action is unclear. Further, as of November 2011, there are 1,302 active leases in the WPA (USDOI, BOEM, 2011), some of which have ongoing exploration, drilling, and production activities or the potential for these activities. Individuals from wide-ranging species that may have been affected by DWH events still have the potential to be affected by these ongoing activities, regardless of whether a WPA proposed action is implemented.

Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives in the WPA for this EIS (including the No Action and Action Alternatives) for three main reasons:

(1) As of November 2011, there are 1,302 active leases in the WPA with ongoing (or the potential for) exploration, drilling, and production activities (USDOI, BOEM, 2011). In addition, non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA proposed lease sale (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 in the WPA is chosen under this EIS. Impacts on marine mammals from either smaller accidental events or low-probability catastrophic events will remain the same.

(2) As discussed in the above sections, some marine mammal populations in the WPA do not generally travel throughout areas affected by DWH spilled oil and would not be subject to a changed baseline or cumulative effects from the DWH event (e.g., coastal bottlenose dolphins resident in the WPA). Other marine mammals, such as Bryde's whales and manatees, although potentially affected by the DWH event, do not typically occur in the WPA.

(3) Other wide-ranging populations of marine mammals (e.g., sperm whales and killer whales) that may occur in the WPA and within areas affected by the spill are unlikely to have experienced population-level effects from the DWH event, given their wide-ranging distribution and behaviors.

4.1.1.11.2. Impacts of Routine Events

The potential effects on marine mammal species may occur from routine activities associated with a WPA 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 will 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. This Agency has issued NTL 2007-G04, 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. While the number of manatees in the WPA is low, the potential for impacts to manatees by vessel traffic cannot be discounted.

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 will 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, 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 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 (i.e., 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, 2007f) and 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 (*Federal Register,* 2003). 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 (*Federal Register*, 2004). 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 (*Federal Register*, 2011b). 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). The Programmatic EA includes a detailed description of the seismic surveying technologies, energy output, and operations, and it is hereby incorporated by reference.

The BOEM has mitigations in place (NTL 2007-G02) that require G&G operators conducting seismic operations in all Federal waters >200 m (656 ft) deep in the WPA and CPA, 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 1 μPa (rms) without reinitiating ramp-up. Procedures for ramp-up, protected species observers' training, visual monitoring, and reporting are described in detail in NTL 2007-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(c)). 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. This Agency 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 2007-G03).

Proposed Action Analysis

The NMFS recognized in their 2007 Biological Opinion for oil and gas activities in the WPA (and CPA) that the routine activities most likely to impact marine mammals (e.g., the sperm whale) were vessel strikes, seismic noise, and structure removals. This Agency 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 2007-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, this Agency's current requirements and guidelines for vessel operation in the vicinity of protected species should minimize this risk (NTL 2007-G04).

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 vessel 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 2007-G03) 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 noninjurous 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 7-13 production structures resulting from a WPA proposed action will be removed using explosives. It is expected that structure removals will 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 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 WPA proposed action (i.e., lease sale) are 64,000-75,000 trips (**Table 3-2**) over the life of a WPA proposed action. This equates to an average annual rate of 1,600-1,875 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 will experience stress or will 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. However, manatees are less common in the western Gulf and, consequently, OCS vessel traffic should pose fewer risks to this species. 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 WPA proposed action (i.e., lease sale) are 290,000-605,000 operations (**Table 3.2**) over the life of a WPA proposed action. This equates to an average annual rate of 7,250-15,125 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 53-89 exploration and delineation wells and 77-121 development wells are projected to be drilled as a result of a WPA proposed action. A total of 15-23 platforms are projected to be installed as a result of a WPA 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 western Gulf (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 WPA. 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 this Agency'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.

Summary and Conclusion

Some routine activities related to a WPA 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.

Although there will always be some level of incomplete information on the effects from routine activities under a WPA 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 WPA proposed action area as a result of existing leases and related activities. As of November 2011, there are 1,302 active leases in the WPA (USDOI, BOEM, 2011). Within the WPA, 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.

4.1.1.11.3. Impacts of Accidental Events

Accidental, unexpected events associated with a WPA proposed action could negatively impact marine mammals. Such impacts would primarily be the result of blowouts, oil spills, and spill-response activities. Each of these is discussed below. Low-probability catastrophic events, similar to the DWH event, are analyzed in **Appendix B**.

Blowouts

A blowout at the seafloor occurs when excess pressure in the well exceeds the capacity (both the operator's and the drilling apparatus' capacity) to contain the well. Improperly balanced well pressures result in sudden, uncontrolled releases of fluids from a wellhead or wellbore. Blowouts can occur during any phase of development, including exploratory drilling, development drilling, production, completion, or workover operations. Depending on the type of blowout, the pressure waves and noise generated by the eruption of gases and fluids would likely be significant enough to harass, injure, or kill marine mammals, depending on the proximity of the animal to the blowout. The probability that a marine mammal will be in the vicinity of a blowout at the exact moment it occurs is relatively small.

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 mucus 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 Authority, 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, 2006a). 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. The Macondo well, however, was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary (**Figure 1-2**).

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. 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). All marine mammals collected either alive or dead were found east of the Louisiana/Texas border. Approximately 4 percent of these strandings (7 total) were in close proximity to the Texas/Louisiana border. The remaining strandings (164 total) were approximately 200 km (124 mi) from the Louisiana/Texas border and at an even much greater distance from the NOAA trajectories of approximate oil locations from April 27, 2010, to May 1, 2010 (USDOC, NOAA, 2010j). 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 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-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 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 WPA 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 as a result of a WPA proposed action is presented in **Table 3-12**. The estimated number of spills ≥1,000 bbl in the WPA is estimated to be <1 spill during the 40-year period of a WPA proposed action. For spills ≥1,000 bbl, the potential causes, volumes, and probabilities associated with a WPA proposed action are presented in **Chapter 3.2.1** and in **Table 3-12. Chapter 41.1.11.3** 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 WPA proposed action.

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 WPA proposed action also means many years for an impact to occur; and (4) some spills will 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 WPA 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 WPA 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 WPA 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 WPA 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. These long-term impacts could have population-level effects (USDOC, NMFS, 2010b).

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." Currently, BOEM, NMFS, and FWS are in the process of collecting and awaiting additional information, which is being gathered as part of the NRDA process in order to update the environmental baseline information as needed for this reinitiated Section 7 Consultation. The BOEM is acting as lead agency in the reinitated consultation, with BSEE involvement. Consultation is ongoing at this time. As BOEM moves forward with this 5-Year Program (2012-2017), BOEM and BSEE are developing a 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 post-lease 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.

4.1.1.11.4. 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 WPA 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 WPA proposed action are described in **Chapter 4.1.1.11.2**. Chapters providing supportive material for the marine mammals analysis include **Chapters 4.1.1.11.1** (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 4.1.1.11.2**, 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 1,600-1,875 round trips in the WPA 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.

This Agency issued NTL 2007-G04, 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 one 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 NOAA 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 BOEM 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 issued “Decommissioning Guidance for Wells and Platforms” (NTL 2010-G05) to offshore operators. These guidelines specify and reference mitigation requirements in the new ESA and MMPA guidance and require trained observers to watch for protected species of 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 4.1.1.11.2,** 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 (*Federal Register*, 2003). In 2004, NMFS published a notice of intent to prepare an Environmental Impact Statement (EIS), notice of public meetings, and request for scoping comments, for the requested authorizations (*Federal Register*, 2004). 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 (*Federal Register*, 2011b). The National Marine Fisheries Service’s EIS has not been completed at this time. In response to terms and conditions in the NMFS’s 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 4.1.1.11.1**, 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 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 WPA (and CPA), 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 4.1.1.11.3**.

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 NMFS's 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 will decrease 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 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, although 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 250.40). 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 BOEM 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 2007-G03).

Vessel strikes are a serious threat to marine mammals in the GOM. A collision between a marine mammal and a ship will result in injury and likely death. The increase in vessel traffic due to aWPA 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. This Agency issued NTL 2007-G04, “Vessel Strike Avoidance and Injured/Dead Protected Species Reporting,” which provides guidance for vessel strike avoidance and reporting in order to minimize the 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. A total of 562 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 (just east of the WPA). More detail on the UME can be found on NMFS’s website (USDOC, NMFS, 2011a).

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 in **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 dolphins 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 Hurricane Gustav. 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.

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, large-scale catastrophic event could have population-level effects on marine mammals

The effects of a WPA 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 2007-G04 ("Vessel Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2007-G03 ("Marine Trash and Debris Awareness and Elimination"), as well as the limited scope, timing, and geographic location of a WPA proposed action, would result in negligible effects from the proposed drilling activities on marine mammals. 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.

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. 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, the 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 applied using accepted scientific methods and approaches. 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 listed below.

(1) As of November 2011, there are 1,302 active leases in the WPA with ongoing (or the potential for) exploration, drilling and production activities (USDOI, BOEM, 2011). In addition, non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA 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. Impacts on marine mammals from either smaller accidental events or low-probability catastrophic events will remain the same.

(2) Some marine mammal populations in the WPA do not generally travel throughout areas affected by spilled oil from the DWH event, and they would not be subject to a changed baseline or cumulative effects from the DWH event (e.g., coastal bottlenose dolphins resident in the WPA). Other marine mammals, such as Bryde's whales and manatees, although potentially affected by the DWH event do not typically occur in the WPA.

(3) Other wide-ranging populations of marine mammals (e.g., sperm whales and killer whales) that may occur in the WPA and within areas affected by the spill are unlikely to have experienced population-level effects from the DWH event given their wide-ranging distribution and behaviors.

Within the WPA, 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 WPA proposed action and its impacts, the incremental effect of a WPA proposed action on marine mammal populations is not expected to be significant when compared with non-OCS energy-related activities.

4.1.1.12. 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.

4.1.1.12.1. 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 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 Gulf of Mexico 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 along the Texas coast 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 Gulf of Mexico (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 with frequency in the GOM. Generally, the offshore species and the offshore habitat are not expected to be severely affected in the long term. However, when species occupy more nearshore habitats and use nearshore habitats for nesting, they 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 Ike in 2008 occurred in areas used by sea turtles for nesting. Hurricane Ike hit the northern Texas coast where Kemp's ridley sea turtles have begun nesting in recent years after decades of nest and hatchling relocation from beaches in Mexico. The massive amount of storm debris from Hurricane Ike littered beaches well into south Texas, including Padre Island, which is a very important Kemp's ridley nesting habitat. Both the washing away of sand beaches and the proliferation of debris on nesting beaches can post major barriers to successful nesting. Although the beach cleanup in Texas will be a long process, the 2009 nesting season showed that the turtles returned despite the prior year's destruction, with 197 Kemp's ridley nests counted (USDOI, NPS, 2009). This was the highest number of nests counted in Texas to date, barely topping the previous record of 195 nests in 2008. 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). Nests documented for 2010 on the Texas coast are from Kemp's ridley sea turtles (141 nests), loggerhead sea turtles (9 nests), and green sea turtles (5 nests) (USDOI, NPS, 2010a).

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 GOM 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 GOM 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). As of 2007, there were no confirmed sightings of leatherbacks coming ashore to nest on beaches adjacent to the WPA in Texas since 1930 (USDOI, FWS, 2007a). Although nesting is relatively rare on the western Gulf of Mexico beaches, leatherbacks occur in Gulf of Mexico waters, including the WPA. The 2007 FWS Biological Opinion stated, "There have been no confirmed sightings of leatherbacks coming ashore to nest within the WPA or CPA since 1930 in Texas. Therefore, the Service [FWS] has determined that the proposed project will not affect nesting leatherback sea turtles" (USDOC, NMFS, 2007b). However, there was a recorded nest site in Texas during the 2008 season (USDOI, NPS, 2008a). 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, and Padre Island National Seashore and South Padre Island are the only locations on the Texas coast where green turtle nesting has been documented (1-5 nests per year) (USDOI, NPS, 2011a).

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 green turtles and immatures 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 of 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 Gulf 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 Gulf of Mexico. 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). Analyses of stomach contents from sea turtles stranded on upper Texas beaches apparently suggest similar nearshore foraging behavior (Plotkin, 1995). 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 along the Texas coast and for marine habitats in the Gulf of Mexico 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). On the Texas coast, 251 Kemp's ridley nests were recorded from 2002 to 2006. For the 2007 nesting season, 128 nests had been recorded. For 2008, the nests in Texas totaled 195; for 2009, there were 197 nests; and for 2010, there were 141 nests (USDOI, NPS, 2011a). Kemp's ridleys are nesting in Padre Island National Seashore, and NPS believes that hatchlings and subadults spend some time in the northern GOM, particularly during the summer months.

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, 2011c).

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 Gulf, 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. Sightings of loggerheads in waters over the continental slope suggest that they may be in transit through these waters to distant foraging sites or while seeking warmer waters during the winter. Although loggerheads are widely distributed during both summer and winter, their abundance in surface waters over the slope was greater during winter than in summer (Mullin and Hoggard, 2000). 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 Gulf of Mexico, 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, 2011c).

In the past decade, a 39.5 percent decline in the annual number of nests has been reported (USDOC, NMFS and USDOI, FWS, 2007e). Texas reported two loggerhead nests in 2006 and six in 2007. For 2008, there were three nests reported in Texas; and for 2010, nine nests were reported.

The NMFS has issued a proposed rule to list nine distinct population segments of loggerhead sea turtles under the ESA (*Federal Register*, 2011c). At this time, none of the distinct population segments are located in the GOM.

Species/Critical Habitat Description

The loggerhead sea turtle was listed as a threatened species on July 28, 1978 (*Federal Register*, 1978). 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, NMFS's 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). Natal homing of females to the nesting beach provides the barrier between these subpopulations, preventing recolonization with turtles from other nesting beaches. 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. The Macondo well, however, was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary (**Figure 1-2**). For the latest available information on oiled or affected sea turtles documented in the area, event response activities, and daily maps of the current location of spilled oil, see RestoreTheGulf.com (2010b). **Figure 4-10** summarizes sea turtles collected by date obtained from the consolidated numbers of collected fish and wildlife that have been reported to the Unified Area Command from FWS, NOAA, incident area commands, rehabilitation centers, and other authorized sources operating within the DWH event impact area through April 12, 2011

According to the 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, NOAA, 2011c). The vast majority of sea turtles collected either alive or dead were found well east of the Louisiana/Texas border and the eastern edge of the WPA (USDOC, NMFS, NOAA, 2011d). However, 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 oil spill.

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, NOAA, 2011c), 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, NOAA, 2011c):

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, NOAA, 2011c.

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 PAHs 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 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 WPA when activities first occur as a result of a WPA proposed action. Without any further data than what exists 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 Western 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 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 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. 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, NOAA, 2011e). No visible external or internal oil was observed in these animals. As of October 6, 2011, the investigation is ongoing but, at this time, NMFS has not identified any information regarding potential strandings in Texas.

Sea Turtle Resources in the Western 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 ultimately 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 spilled and active response/cleanup activities from the DWH event on sea turtles 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 increased stranding event.

Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to sea turtles in the WPA. Relevant data on the status of sea turtle populations 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. 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 applied using accepted scientific methods and approaches.

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 two main reasons:

(1) As of November 2011, there are 1,302 active leases in the WPA with ongoing (or the potential for) exploration, drilling, and production activities (USDOI, BOEM, 2011). In addition, non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA proposed action (i.e., fishing, military activities, scientific research, and shoreline development). 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 sea turtles from either smaller accidental events or low-probability catastrophic events will remain the same.

(2) All wide-ranging populations of sea turtles that may occur in the WPA and within areas affected by the spill are unlikely to have experienced population-level effects from the DWH event given their wide-ranging distribution and behaviors.

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 event 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 Bureau of Ocean Energy Management 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 is 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 post-lease 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.

4.1.1.12.2. Impacts of Routine Events

Background/Introduction

Routine activities resulting from a WPA proposed action have the potential to harm sea turtles, although this potential is unlikely to rise to a level of significance. The major impact-producing factors resulting from the routine activities associated with a WPA 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 in the wild. 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 will 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 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), and one loggerhead in 2001 (Gitschlag, official communication, 2001), and two loggerhead deaths in 2010 were reported to BOEMRE. 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's 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*, 1995). 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, 1987b; 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, 1987b). 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 WPA 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 Gulf 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 4.1.1.5.2 and 4.1.1.6.2**. 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 WPA 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 2.3.1.3.3**).

An estimated 64,000-75,000 service-vessel round trips are expected to occur annually as a result of a WPA proposed action. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter operations are expected to be 290,000-605,000 (take-offs and landings) per year as a result of a WPA 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 will 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 WPA 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 WPA 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 less than 200 m (656 ft) (USDOC, NMFS, 2007b). To further minimize the potential for vessel strikes, NTL 2007-G04 was issued; this NTL clarifies 30 CFR 250.282 and provides NMFS guidelines for monitoring procedures related to vessel strike avoidance measures for sea turtles and other protected species. With 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 BSEE monitors 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 and NTL 2007-G04).

To date, there have been no reported strikes of sea turtles by drilling vessels. Given the scope, timing, and transitory nature of a WPA proposed action and with this established mitigation, the effects to sea turtles from drilling vessel collisions is expected to be negligible.

A total of 53-89 exploration wells and 77-121 producing development wells are projected to be drilled as a result of a WPA proposed action. A total of 15-23 platforms are projected to be installed as a result of a WPA proposed action. Of those, 7-13 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, and 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 2007-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 WPA proposed action.

In 30 CFR 250 Subpart B, BSEE requires 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 proposes compliance with the guidelines provided in NTL 2007-G03, "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 WPA proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or populations in the GOM.

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 WPA 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.

Although there will always be some level of incomplete information on the effects from routine activities under a WPA proposed action on sea turtles, 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 WPA proposed action area as a result of existing leases and related activities. (As of November 2011, there are 1,302 active leases in the WPA [USDOI, BOEM, 2011]). Within the WPA, 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 sea turtle 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.

4.1.1.12.3. Impacts of Accidental Events

This chapter discusses the impacts of accidental events associated with a WPA 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 Shigenaka et al. (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 predive 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 mucus 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 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 the "take" of sea turtles. 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, "[w]hether 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 WPA proposed action have the potential to harm sea turtles. The major impact-producing factors resulting from the accidental activities associated with a WPA 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 of Mexico. 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 5-8 percent and 8-14 percent probability of contacting Texas State offshore waters, based on a WPA proposed action (**Figure 3-8**). State offshore waters of western Louisiana have a <0.5 percent and 1 percent risk based on 10- and 30-day probabilities, respectively, of contact from an OCS spill occurrence resulting from a WPA proposed action. There is a <0.5 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River from a WPA proposed action The OSRA model projected a spill risk of a <0.5 percent for State waters eastward of Louisiana as a result of a WPA proposed action (**Figure 3-8**).

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters and contacting coastal GOM counties/parishes due to a WPA proposed action would impact a total of 10 counties/parishes with a >0.5 percent probability (**Figure 3-9**). The Chandeleur Islands have a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action (**Figure 3-25**). The Tortugas Ecological Reserve and Dry Tortugas have a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action. The Florida Keys National Marine Sanctuary has a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action (**Figure 3-25**).

In general terms, coastal waters of the WPA 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 proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters compared with platforms and tankers (**Chapter 3.2.1.5**). Spill estimates for the WPA 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 million bbl) 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**).

Because oil spills introduced specifically in coastal waters of Texas and Louisiana are assumed to impact adjacent lands, there is likelihood that spilled oil will impact sea turtle nesting beaches in these states. Nesting beaches along south Texas, such as the Padre Island National Seashore, are susceptible to such spills, thereby potentially impacting the recovery of Kemp’s ridley, hawksbill, green, and loggerhead sea turtle populations in the western Gulf. 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 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 will 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 will 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 will 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 will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with a WPA 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 WPA proposed action may introduce 2.510-3.696 BBO and 12.539-18.434 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 Gulf will be exposed to residuals of oils spilled as a result of a WPA 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, 2005a). Sea turtles are vulnerable to oil and dispersants at all life stages (i.e., eggs, post-hatchlings, juveniles, subadults 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, 2010l; 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 4.1.1.12.1**). 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 believes 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 WPA proposed action (USDOC, NMFS, 2007b). However, NMFS is not including the incidental take of listed species due to oil exposure in this 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 WPA proposed action, 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 ESA.

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a WPA proposed action 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 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 a WPA proposed action area, regardless of any alternative selected under this EIS, given that, as of November 2011, there are 1,302 active leases in the WPA, with either ongoing or the potential for exploration, drilling, and production activities (USDOI, BOEM, 2011).

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.

The BOEM concludes that there 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 event. Relevant 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. 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. In the absence of this information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis applied using accepted scientific methods and approaches. The BOEM does not, however, believe this incomplete information is essential to make a reasoned choice among alternatives primarily because activities that could result in an accidental spill in the WPA would be ongoing whether or not a WPA proposed action occurred. As of November 2011, there are 1,302 active leases in the WPA that are engaged, or have the potential to be engaged in exploration, drilling and/or production activities that could theoretically result in an accidental spill (USDOI, BOEM, 2011). Given these existing leases and this ongoing activity, any incomplete information that may lead to reasonably foreseeable, significant adverse impacts to sea turtles is not needed to make a reasoned choice among alternatives, including the No Action alternative.

4.1.1.12.4. Cumulative Impacts

This cumulative analysis considers the effects of impact-producing factors related to a 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 the proposed actions in the WPA.

Proposed Action Analysis

The major impact-producing factors resulting from cumulative OCS energy-related activities associated with a WPA 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 WPA proposed action that may occur are reviewed in detail in **Chapter 4.1.1.11**. Chapters providing supporting material for the sea turtle analysis include **Chapters 4.1.1.1** (air quality), **4.1.1.2** (water quality), **4.1.1.3** (coastal barrier beaches and associated dunes), **4.1.1.5** (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 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, 1987b; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; Lutz and Alfaro-Shulman, 1992). The BSEE regulate the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.300). In addition, MARPOL Annex V (P.L. 100-220; 101 Statute 1458), prohibits the disposal of plastics at sea or in coastal waters.

The BSEE proposes compliance with the guidelines provided in NTL 2007-G03, "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 Gulf 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 will 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). Due to 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 WPA proposed action. Collisions between service vessels or barges and sea turtles would likely cause fatal injuries. It is projected that 64,000-75,000 OCS-related, service-vessel round trips would occur annually in support of OCS activities in the WPA (**Table 3-2**). 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, this Agency issued NTL 2007-G04, "Vessel Strike Avoidance and Injured/ Dead Protected Species Reporting," clarifies 30 CFR 550.282 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 WPA 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 WPA proposed action area. Thus, operations of vessels by Federal agencies within the WPA 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 290,000-605,000 OCS-related helicopter operations (take-offs and landings) would occur annually in the support of OCS activities in the WPA (**Table 3-2**). 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 2007-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 BSEE 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 160-240 explosive structure removals are projected to occur in the WPA (**Table 3-5)** between 2012 and 2051.

To minimize the likelihood of removals occurring when sea turtles may be nearby, BSEE 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's 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 WPA proposed action.

In 30 CFR 250 Subpart B, BSEE requires 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. 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 will 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 six 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 (De Silva, 1998).

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) and Texas (Manzella and Williams, 1992). Juvenile hawksbill, loggerhead, and green turtles are typically found in coastal Texas waters (Shaver, 1991). 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 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

Deepwater 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. One application has been denied; eight applications have been withdrawn (Beacon Port and Texas Offshore Port System in the WPA); and one application is currently under review (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.

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 WPA 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 2007-G04 ("Vessel Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2007-G03 ("Marine Trash and Debris Awareness Elimination"), as well as the limited scope, timing, and geographic location of a WPA 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.

Adverse effects may result from the incremental contribution of a WPA 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 WPA proposed action on sea turtles are expected to be negligible for drilling and vessel noise and minor for vessel collisions, but it will 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 WPA 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 WPA proposed action, incremental effects from the proposed drilling activities on sea turtles will 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 WPA proposed action's 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 WPA proposed action is mainly focused on the individual. Population-level impacts are not anticipated based on the best available information.

Unavailable information on effects to sea turtles from the DWH event (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 foreseeable significant adverse impacts to sea turtles. Relevant data on the status of sea turtle populations after the DWH event and increased sea turtle GOM strandings 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 based upon accepted scientific methods and approaches. 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 two main reasons listed below:

(1) As of November 2011, there are 1,302 active leases in the WPA with ongoing (or the potential for) exploration, drilling, and production activities (USDOI, BOEM, 2011). In addition, non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA proposed action (i.e., fishing, military activities, scientific research, and shoreline development). 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 sea turtles from either smaller accidental events or low-probability catastrophic events will remain the same.

(2) All wide-ranging populations of sea turtles that may occur in the WPA and within areas affected by the spill are unlikely to have experienced population-level effects from the DWH event given their wide-ranging distribution and behaviors.

Within the WPA, 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 sea turtle populations. Therefore, in light of the above analysis of a WPA proposed action and its impacts, the incremental effect of a WPA proposed action on sea turtle populations is not expected to be significant when compared with non-OCS energy-related activities.

In any event, the incremental contribution of a WPA proposed action would not be likely to result in a significant incremental impact on sea turtles within the WPA; in comparison, non-OCS-related activities such as overexploitation, commercial fishing, and pollution have historically proved to be of greater threat to the sea turtle species.

4.1.1.13. Diamondback Terrapins

4.1.1.13.1. 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 one subspecies of terrapin that occurs in the WPA and that is a Federal species of concern is the Texas diamondback terrapin (*Malaclemys terrapin littoralis*). The Texas diamondback terrapin (listed November 15, 1994) has a range from Louisiana through Texas (USDOI, FWS, 2011a).

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 Texas terrapins, female Florida terrapins on the east coast reached 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 terrapins are be 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 (Butler et al., 2004). 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 loss of beach habitat, are known to have occurred and to impact terrapin populations that would have used those areas for nesting beaches.

Deepwater Horizon Event

Given that the boundary of the WPA is more than 300 mi (483 km) from the Macondo well and that the westernmost extent of the plume and sheen did not reach the WPA, it appears that Texas terrapins would not have been impacted by the DWH event. Data collected by the Operational Science Advisory Team indicate that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). The DWH event and associated oil spill is unlikely to have impacted the terrapin community and associated brackish habitats, although minimal oil (in the form of a small number of tarballs that are believed to have formed from transported in by vessel) reached the waters of the WPA. The *Deepwater Horizon* Unified Command reports daily fish and wildlife collection reports that include turtles; these reports can be found at RestoreTheGulf.gov (2011a). As of April 20, 2011, two other reptiles (not yet identified as terrapin and other than sea turtles) have been collected in the CPA (RestoreTheGulf.gov, 2011a). No known terrapins have been collected in Texas to date. 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.

Diamondback Terrapin Resources in the Western Planning Area

The final determinations on damages to diamondback terrapin resources from the DWH event will ultimately be made through the NRDA process, although current data indicate that the Macondo spill never reached terrapins and their brackish habitats in the WPA. 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 the 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. The BOEM concludes that the unavailable information from these events may be relevant to foreseeable, significant adverse impacts to diamondback terrapins in the WPA. 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 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 based upon accepted scientific methods and approaches.

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). As of November 2011, there are 1,302 active leases in the WPA with ongoing (or the potential for) exploration, drilling and production activities (USDOI, BOEM, 2011). In addition, non-OCS-energy related activities will continue to occur in the WPA irrespective of a WPA proposed action (i.e., crabbing, fishing, military activities, scientific research, and shoreline development). The potential for effects from changes to the affected environment (post-DWH event), 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.

Further, the analyses in this EIS and in **Appendix B** conclude that there is a low-probability for catastrophic events to result in significant, population-level effects on affected diamondback terrapin species. The BOEM continues to agree with these conclusions irrespective of any incomplete information, changes to the existing environment from the DWH event, or even the effectiveness of implementation of the improved post-DWH safety and oil-spill-response requirements.

4.1.1.13.2. Impacts of Routine Events

Background/Introduction

The major impact-producing factors resulting from the routine activities associated with a WPA proposed action that may affect the Texas diamondback terrapin (*Malaclemys terrapin littoralis*) 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 WPA 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. This Agency has established guidelines provided in NTL 2007-G03, "Marine Trash and Debris Awareness and Elimination," which appreciably reduces the likelihood of encountering marine debris from a WPA 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 activities 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, this Agency issued NTL 2007-G04, which clarifies 30 CFR 550.282 and provides NMFS guidelines for monitoring procedures related to vessel strike avoidance measures, including for this species. The BOEM monitors 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 and NTL 2007-G04). 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 WPA proposed action. **Chapter 4.1.1.4.2** provides further details 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 WPA proposed action.

Summary and Conclusion

Adverse impacts due to routine activities resulting from a WPA 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 WPA 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.

Although there will always be some level of incomplete information on the effects of routine activities on diamondback terrapin under a WPA proposed action, 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 WPA proposed action area as a result of existing leases and related activities. As of November 2011, there are 1,302 active leases in the WPA (USDOI, BOEM, 2011). Within the WPA, 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. 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.

4.1.1.13.3. Impacts of Accidental Events

Background/Introduction

The major impact-producing factors resulting from the accidental events associated with a WPA proposed action that may affect the Texas diamondback terrapins (*Malaclemys terrapin littoralis*) 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 WPA 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 WPA 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 terrapins 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, although only minimal oil reached the waters of the WPA. 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; however, the WPA estuarine environments were not affected by the DWH event.

Accidental blowouts, oil spills, and spill-response activities resulting from a WPA 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 WPA 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, 2005a). The impacts to diamondback terrapins from chemical dispersants could include nonlethal injury (e.g., tissue irritation, 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 5-8 percent and 8-14 percent probability of contacting Texas State offshore waters based on a WPA proposed action (**Figure 3-9**). State offshore waters of western Louisiana have a <0.5 percent and 1 percent risk based on 10- and 30-day probabilities, respectively, of contact from an OCS spill occurrence resulting from a WPA proposed action. There is a <0.5 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River from a WPA proposed action The OSRA model projected a spill risk of <0.5 percent for State waters eastward of Louisiana as a result of a WPA proposed action (**Figure 3-9**).

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters and contacting coastal GOM counties/parishes due to a WPA proposed action would impact a total of 10 counties/parishes with a >0.5 percent probability (**Figure 3-10**). The Chandeleur Islands have a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action (**Figure 3-25**). The Tortugas Ecological Reserve and Dry Tortugas have a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action. The Florida Keys National Marine Sanctuary has a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action (**Figure 3-25**).

In general terms, coastal waters of the WPA 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 proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters compared with platforms and tankers (**Chapter 3.2.1.5**). Spill estimates for the WPA 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 million bbl) 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)**.

Spending most of their lives at the aquatic-terrestrial boundary in estuaries, terrapins are susceptible to habitat destruction from cleanup efforts, as well as direct oil contact. 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. Nests can also be disturbed or destroyed by cleanup efforts.

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 the WPA proposed action area, regardless of any alternative selected under this EIS, given that, as of November 2011, there are 1,302 active leases already in the WPA with either ongoing or the potential for exploration, drilling, and production activities (USDOI, BOEM, 2011).

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.

The BOEM concludes that there is incomplete or unavailable information that may lead to reasonably foreseeable, significant adverse impacts to diamondback terrapins from accidental events. For example, there is incomplete information on impacts to diamondback terrapin populations from the DWH event or from impacts that could result from a similar catastrophic spill. Relevant data on the status of and impacts to diamondback terrapin populations from the DWH may take years to acquire and analyze, and impacts from the DWH 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 the absence of this information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches.The BOEM does not, however, believe this incomplete information is essential to make a reasoned choice among alternatives primarily because activities that could result in an accidental spill in the WPA would be ongoing whether or not a WPA proposed action occurred. As of November 2011, there are 1,302 active leases in the WPA that are engaged, or have the potential to be engaged, in exploration, drilling, and/or production activities that could theoretically result in an accidental spill (USDOI, BOEM, 2011). Given these existing leases and this ongoing activity, any incomplete information that may lead to reasonably foreseeable, significant adverse impacts to diamondback terrapins is not needed to make a reasoned choice among alternatives, including the No Action alternative.

4.1.1.13.4. Cumulative Impacts

Background/Introduction

The major impact-producing factors that may affect the Texas diamondback terrapin (*Malaclemys terrapin littoralis*) 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 WPA 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 WPA 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 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.

Given that the boundary of the WPA is more than 300 mi (483 km) from the Macondo well and that the westernmost extent of the plume and sheen did not reach the WPA (**Figure 1-2**), it appears that Texas terrapins would not have been impacted by the DWH event. Data collected by the Operational Science Advisory Team indicate that the DWH spill did not reach WPA waters or sediments (OSAT, 2010). The DWH event and associated oil spill is unlikely to have impacted the terrapin community and associated brackish habitats, although minimal oil (in the form of a small number of tarballs that are believed to have formed from transported in by vessel) reached the waters of the WPA. The DWH event and associated oil spill may have potentially impacted the terrapin community, although only minimal oil reached the waters of the WPA. Impacts can be either direct (mortality or injury) or indirect (e.g., reduced prey availability); however, most impacts cannot be quantified at this time and are believed to be negligible. As discussed in **Appendix B**, a low-probability, large-scale 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 WPA estuarine environments were not affected by the DWH event.

The effects of a WPA 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 2007-G04 ("Vessel-Strike Avoidance") and NTL 2007-G03 ("Marine Trash and Debris"), as well as the limited scope, timing, and geographic location of a WPA 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.

Summary and Conclusion

Texas 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 WPA proposed action includes only limited shoreline crossings and modern regulations require mitigation of wetland impacts. Low-probability, large-scale 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 WPA 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 WPA 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 WPA 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, the conclusions in these analyses on 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).

Unavailable information on the effects to diamondback terrapins from the DWH event (and thus changes to the diamondback terrapin baseline in the affected environment) makes an understanding of the cumulative effects less clear, although current data indicate that the Macondo spill never reached terrapins and their brackish habitats in the WPA. 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 may take years to acquire and analyze, and impacts from the DWH 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 based upon accepted scientific methods and approaches.

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). As of November 2011, there are 1,302 active leases in the WPA with ongoing (or the potential for) exploration, drilling, and production activities (USDOI, BOEM, 2011). In addition, non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA proposed action (i.e., crabbing, fishing, military activities, scientific research, and shoreline development). 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 WPA, 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 diamondback terrapin populations. Non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA proposed lease sale (i.e., crabbing, fishing, military activities, scientific research, and shoreline development). Therefore, in light of the above analysis on a WPA proposed action and its impacts, the incremental effect of a WPA 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.

4.1.1.14. 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 are expected to be adverse, but not 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 WPA 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.

4.1.1.14.1. Description of the Affected Environment

The following information is a summary description of coastal and marine birds. An extensive search of Internet bibliographic databases was conducted to determine the availability of recent information. New information (National Oil Spill Commission, 2011c; USDOI, FWS, 2010a) 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-based 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**). 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 (denoted by superscript "a" in **Tables 4-8, 4-12, 4-13 and 4-15**), species with a high probability of oiling in the event of a spill (denoted by superscript "b" in **Tables 4-8 and 4-13**), 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, 2010a). The estimates provided below are based on published scientific methodologies and available DWH event data for birds (USDOI, FWS, 2010a; King and Sanger, 1979; Williams et al., 1995; Camphuysen, 2006).

For the WPA, only Bird Conservation Region 37 was considered, as the other two BCR's encompass areas outside the WPA. Bird Conservation Region 37 includes 44 Birds of Conservation Concern, of which 30 (68.2%) are considered as having a potential to be impacted by offshore oil and gas development, with 20 (45.4%) representing species with a high probability of oiling. 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. National Wildlife Refuges with a marine component are located in Louisiana (n = 7; 250,070 ac [101,200 ha]) and Texas (n = 10; 493,968 ac [199,902 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). Refer to the North American Bird Conservation Initiative annual reviews of the state of the Nation's avian resources for more information (North American Bird Conservation Initiative, 2009, 2010, and 2011).

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 (numbers in parentheses represent breeding and wintering) by states (1950-2011) are as follows: Louisiana (251, 434) and Texas (482, 629). The breeding period was defined as occurring in June-July, whereas the wintering period included all other months. Seven generic bird groups are described: diving birds; seabirds; shorebirds; passerines (songbirds); marsh and wading birds; waterfowl; and raptors.

Some species occur primarily in the pelagic (offshore) environment (e.g., northern gannet; and 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, 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 4-8 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; 1 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 noctural 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).

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); Suidae (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; Portnoy, 1981). The seabirds include both breeders (pelicans, laughing gulls, 8 species of terns, and black skimmers) and nonbreeders, with some of the breeders considered year-round residents of the Gulf of Mexico. 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).

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.

Most of the GOM seabirds forage exclusively on small fish and feed by plunge-diving, often from a hovering position. Terns, and 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) and habitat loss (Goss-Custard et al., 1995; Norris, 2005; Newton, 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 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**). (Russell, 1999, Table 1). 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.

Table 4-13 includes information on avian life history and demography. A more detailed discussion of avian demography and population recovery potential are addressed in the DWH baseline conditions section 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). There are five families of Gulf of Mexico shorebirds: 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 Calidrid 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 (Skagen and Knopf, 1993; Krapu et al., 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; North American Bird Conservation Initiative, 2010). A more detailed discussion of the potential effects of climate change on birds will be 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 (Galbraith et al., 2002; Norris et al., 2004; MacLean 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).

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 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 considered herein (except introduced species – 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).

Marsh and Wading Birds

There are four families of wading birds 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).

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.

A census of south Louisiana wading bird nesting colonies was completed in 2001 (Michot et al., 2003; see also Hunter et al., 2006). Within the central Gulf Coast region, Louisiana supports the majority of nesting wading birds (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).

For additional information on the two Pelagic BCR's in the Gulf of Mexico and the associated priority marsh- and waterbirds species, refer to Kushlan et al. (2002) and Hunter et al. (2006). 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 WPA: the 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 Louisiana include yellow, black, clapper, and king rail; American bittern; reddish egret; yellow-crowned night heron; and wood stork. State-listed species in this group for Texas include reddish egret, white-faced ibis, wood stork, and whooping crane.

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 5 representative species of ducks and 1 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 (e.g., primarily Texas, though they may occur in southwestern 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 (~741 mi^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 marshes.

For a more detailed discussion of wintering waterfowl habitats, habitat loss, contaminants, and their effects on wintering waterfowl populations in the GOM, refer to Cain (1988), Chabreck et al. (1989), and Stutzenbaker and Weller (1989).

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. Five families are represented: Cathartidae (black and turkey vulture); Accipitridae (eagles, kites, accipiters, buteos, and osprey; numerous representatives); Falconidae (4 representatives); Tytonidae (barn owl); and Strigidae (several representatives). All raptors are protected under the Migratory Bird Treaty Act. The bald eagle is afforded additional protection under 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). The northern aplomado falcon is federally listed as endangered, but its range in the Gulf Coast States is limited to only Texas; including an experimental population (**Table 4-14**). A 5-year status review was completed for the northern aplomado falcon on March 29, 2010 (75 FR 15454-15456).

Raptors listed as state species of conservation concern include the following: Louisiana (swallow-tailed kite, bald eagle, northern harrier, and short-eared 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 will be described in more detail below.

Threatened and Endangered Species

Table 4-14 provides information for each of the 17 species considered including its status, critical habitat designations, states in which it occurs, planning areas, and information on the DWH event. Birds included in this table were recommended for consideration by FWS (USDOI, FWS, official communication, 2011b). The following summary and **Tables 4-13** and 4-14 represent new information.

Twelve avian species that occur in the WPA are considered with regard to endangered and threatened protections: 2 threatened, 5 endangered, 2 candidate, and 3 celisted (**Table 4-14**). All 12 avian species are likely to be found either breeding or wintering in the WPA (**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 (see below). The red-cockaded woodpecker, Attwater's prairie chicken, northern aplomado falcon, mountain plover, Sprague's pipit, and red knot are not considered further because of their status (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. Thus, these species were not analyzed as they are not likely to be adversely affected by a WPA proposed action (**Table 4-14**).

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 (932 collected, 377 visibly oiled, 40% oiling rate), followed by the least tern (111 collected, 53 visibly oiled, 48% oiling rate) (**Tables 4-8 and 4-13**). As of December 14, 2010, only a single, unoiled piping plover had been collected (**Table 4-8**). Demographic information and recovery potential for the brown pelican and least tern is provided in **Table 4-13** and is described below. Although there were at least some birds collected in the WPA after the DWH event, there is insufficient geospatial data to determine whether any oiled birds were collected in the WPA.

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 WPA 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

Two populations of piping plovers (*Charadrius melodus*) winter along the Gulf Coast and are recognized under the Endangered Species Act: Great Lakes (endangered) and Great Plains (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).

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 5-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). Within the WPA, there are 7 units (parcels of land designated as critical habitat) in Louisiana and 37 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, 1990a). Mississippi, Louisiana, and Texas coasts harbor 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 Biological Opinion (September 17, 2007) relative to Gulf of Mexico OCS oil and gas lease sales under the 2007-2012 5-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 December 14, 2010, 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, 2010a). This also 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-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 there is not sufficient information on the collection of the single piping plover to determine if it was collected in the WPA, it is possible the one unoiled bird was a nesting piping plover from coastal Louisiana. 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 and USDOI, FWS, 2007; USDOI, FWS, 2009b). More recently, a release site was added in Louisiana (**Table 4-14**). 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." 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 form 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 these 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 and USDOI, FWS, 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 and USDOI, FWS, 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**). 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 5-Year Status Review was provided on March 29, 2010 (75 FR 15454 15456). Critical habitat along the Gulf Coast occurs at Aransas National Wildlife Refuge (Texas) (see USDOI, FWS, 2009b, Figure 1). The only critical habitat in the Gulf of Mexico is in the WPA (**Table 4-14**).

At the time of the Biological Opinion (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 December 14, 2010, no whooping cranes had been collected as part of the post-DWH monitoring (**Table 4-8**) (USDOI, FWS, 2010a).

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).

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 3rd subspecies, the Eastern least tern is not federally listed, but it 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).

The most recent (September 17, 2007) Biological Opinion conducted by FWS relative to OCS activities indicated that least terns were “not likely to be impacted by the proposed action,” and therefore were “not analyzed” (USDOI, FWS 2007a). As of December 14, 2010, 111 (53 oiled; 48% oiling rate) least terns had been collected and reported as part of monitoring efforts related to the DWH event (**Table 4-8**) (USDOI, FWS, 2010a).

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 (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).

Louisiana and Texas 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 the FWS (USDOI, FWS, 2009c). This estimate includes the following number of breeding pairs: 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).

The most recent (September 17, 2007) Biological Opinion conducted by FWS relative to OCS activities concurred with this Agency’s determination that a WPA proposed action was not likely to adversely affect this species (USDOI, FWS 2007a). As of December 14, 2010, no bald eagles had been collected and reported as part of monitoring efforts related to the DWH event (**Table 4-8**) (USDOI, FWS, 2010a).

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. No critical habitat rules were ever published for this species. 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). A 5-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.

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, p. 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, thereby 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 December 14, 2010, 932 brown pelicans had been collected as part of monitoring efforts related to the DWH event; second only behind the laughing gull (n = 3,354, 40% oiling rate) in number of birds collected. Of the 932 pelicans collected, 377 were visibly oiled (40% oiling rate) and of those visibly oiled birds, 150 were dead (**Table 4-8**) (USDOI, FWS, 2010a). 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 adverse impacts to their continued recovery in the northern Gulf of Mexico. As noted in the analysis on the DWH event, while birds were apparently collected in the WPA following the DWH event, it does not appear that these impacts are likely to result in population-level impacts in the WPA.

At the time of the Biological Opinion (September 14, 2007), the brown pelican was still listed and was therefore considered in the impact analysis by FWS. At that time, FWS concluded that ". . . the Service concurs with your determination that the proposed action is not likely to adversely affect the brown pelican" (USDOI, FWS, 2007a). In light of the "take" associated with the DWH event, it seems reasonable and prudent to consider this delisted species as part of the NEPA process under the "Endangered and Threatened Species" section. Due to its relatively wide distribution across the northern Gulf of Mexico, it should be 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 the effects from Hurricane Katrina primarily in southeastern Louisiana (and coastal Mississippi and Alabama) and from Hurricane Rita in southwestern Louisiana (and Texas). Barras (2007a, 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. Farther 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. (2011) documented a 57 percent decline in forest canopy cover, resulting in major changes in the avian community composition.

Interestingly, Brown et al. (2011) 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- 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.

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, 2010b). 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, was destroyed. Hurricanes have historically 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 et al., 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 the 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., 2011). 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- 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., 2011). 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. However, any negative effects were almost certainly less in the WPA compared with the CPA (USDOI, FWS, 2010a). The Macondo well was located more than 300 mi (483 km) from the eastern boundary of the WPA, and NOAA has estimated that the most western extent of visible sheens related to oil from the DWH event extended no farther than Cameron Parish, Louisiana, to the east of the WPA boundary (**Figure 1-2**). Due to the oiling being mostly restricted to the CPA, a more thorough treatment and discussion of its impacts to birds has been reserved for **Chapter 4.2.1.16.2**. As of December 14, 2010, FWS had reported 102 avian species identified, representing a total of 8,066 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 (39% oiled, 50% unoiled, 11%

unknown) (**Tables 4-8 and 4-13**). Similarly, considering only the dead birds collected (n = 6,045), a small fraction were oiled (34.2%) compared with unoiled, dead birds (51.5%). 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 event, in combination with annual mortality of birds associated with offshore oil and gas platforms in the Gulf of Mexico (Russell, 2005), represents a small proportion of the total annual mortality compared with other anthropogenic sources (**Table 4-7**).

It has been well documented that the number of birds collected after a spill actually represents a small fraction (0-59% with a mean recovery rate of 17%; Piatt and Ford, 1996) of the total avian mortality (**Tables 4-8 and 4-15** and references therein). Five species of diving birds, 25 species of seabirds, 13 species of shorebirds, 21 species of passerines, 21 species of marsh- and wading birds, 11 species of waterfowl, and 6 species of raptors are known to have been impacted by the DWH event (**Table 4-8**).

For most species herein we lack sufficient data to conduct in-depth perturbation, sensitivity, or population viability analyses (Boyce, 1992; Beissinger and Westphal, 1998) even though these types of analyses are critical for making informed management decisions (Martin et al., 2009; Johnson and St. Laurent, 2011). 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).

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 time that the individuals lost to the event would have otherwise reached breeding age. Individual life-history strategies, starting population size and trajectory, and sex/age composition of the population prior to the DWH event will ultimately dictate the impacts at the population level. Threatened and endangered avian species may be the most impacted because their populations may be starting at a point below (i.e., small population size, reproductively isolated from other members of the species due to habitat loss or fragmentation, population trajectory is declining) what is considered a stable population prior to any major perturbation. Such populations were listed due to a combination of factors that may include habitat loss or fragmentation, being habitat or food specialists, or having a life-history strategy that simply limits their ability to quickly recover from losses (Fahrig, 1997; Root, 1998). Therefore, any additional losses to listed populations could lead to steeper declines in population trajectories, longer recovery times, or in some cases, local extirpation (Plissner and Haig, 2000; Benton, 2003). Threatened and endangered avian species are addressed in more detail in the section above.

The oil from the DWH event has had serious direct and indirect impacts to coastal and marine birds, but such effects were likely 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 and their populations at this time (**Tables 4-8, 4-12, and 4-13**; **Figures 4-16 and 4-17**). Information specific to birds and potential impacts in the WPA remains incomplete or unavailable at this time, although as noted above, many species are unlikely to have been impacted since the oil plume resulting from the DWH event remained east of the WPA boundary. This information is being developed through the NRDA process, which may take many years, and what information NRDA has compiled to date is not publicly available at this time. 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—it cannot be obtained at this time under any circumstances. The BOEM subject-matter experts have applied what additional scientifically credible information is available using accepted scientific methodologies. Although this information may be relevant to reasonably foreseeable significant impacts on birds, BOEM does not believe it is essential to a reasoned choice among alternatives because effects of the DWH event, as evidenced by impacted birds that may have migrated into the WPA, would not be expected to rise to population-level impacts in the WPA. As described above, many species either do not laterally migrate from the CPA to the WPA, were not in residence during the DWH event, and/or their habitat was not affected. As such, impacts to most birds in the WPA would tend to be indirect through later migrations into or from the CPA and through impacts to prey or habitat.

4.1.1.14.2. 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, 17 January 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);
- 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, 2005b); 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 to 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 the potential effects of these various impact-producing factors and the efficacy of regulations for limiting such 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.**

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; Benton, 2003; 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 3-12, 3-13, 3-16, 3-19, 4-21, and 4-28**). 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, and 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).

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 more 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 (Block and Brennan, 1993; Johnson, 2005).

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 (Knutson et al., 2006). This may have short-term or long-term implications depending on the species (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 between 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 (Bélanger and Bédard, 1989; Conomy et al., 1998a; 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:

- behavioral changes (Bélanger and Bédard, 1990);
- reduced pairing success (Habib et al., 2007);
- selection of alternative habitats that may be suboptimal;
- creating barriers to movement or decreasing available habitat (Bayne et al., 2005a and 2005b);
- decreases in foraging time (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 (Béchet et al., 2004; 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, which is 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 frequently, i.e., 20-41 flights/day (**Tables 3-2, and 3-5**; see also **Tables 3-14 and 3-15**), in most cases, such disturbances tend to be relatively short in duration (**Figures 4-24 and 4-25**).

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 volatile organic compounds (VOC's), and the overall activity of flaring increased. For 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; **Chapter 4.1.1.1.2 and Table 4-1**). Effects of air pollutants on birds can result in major die-offs or effects can be relatively subtle including behavioral changes, changes in distribution and habitat use, increased susceptibility to parasites, diseases, and infections, physiological and respiratory stress, and anemia (Newman, 1979; Newman and Schreiber, 1988; Eeva et al., 1994). Newman and Schreiber (1988) stated that the low number of reported incidents involving wildlife is likely a function of lack of awareness and recognition of the problem rather than a low incidence of occurrence (Newman and Schreiber, 1988, Tables 1-2). Air pollution may result in changes to avian populations through their distribution or abundance, but it may be difficult to separate emission-related effects from other population-limiting factors (i.e., food limitation, change in distribution of preferred foods, weather-related effects to habitats, or anthropogenic impacts to habitats, etc.) and their interactions (Schreiber and Newman, 1988, p. 350). In addition, cross-seasonal effects or annual variation in recruitment or mortality may be occurring in other regions (e.g., food shortage on the wintering grounds or on staging areas, major mortality event during migration [Newton 2006 and 2007]), masking air pollution effects or making it more difficult to discern such effects.

Recovery potential for a species or its ability to withstand additional population-level losses due to human-related 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 Figures 4-18 and 4-19**). It is likely that birds using the WPA would encounter less total air pollution than birds using the CPA due to (1) fewer platforms and less flaring from platforms at a given point-in-time in the WPA than CPA, (2) fewer total vessel trips in the WPA than CPA, and (3) fewer helicopter support trips in the WPA than CPA (see "Proposed Action Analysis" section below and **Tables 3-2 and 3-5**). Therefore, total air pollution associated with a WPA proposed action would likely be less in the WPA than CPA (refer to **Table 4-1** for air quality standards). 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.

Produced Water

Produced water impacts on birds can vary from short term to long term and from sublethal to lethal (**Chapter 3.1.1.4**). 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). The reasons are based on the following assumptions:

(1) the regulatory limits established by USEPA eliminate or significantly reduce the potential for negative effects to birds; and

(2) produced water and its constituent pollutants will be diluted simply as a function of the dilution potential of the ocean, eliminating or 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. NTL 2007-G03 was issued on February 7, 2007, 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, and Poot et al., 2008). Circulations put birds at risk for collision with platforms (Russell, 2005).

Annual mortality estimates for birds migrating across the GOM are roughly 200,000-321,000 birds (**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 (**Figures 3-5 and 4-21**) occurs in what was historically an otherwise featureless landscape (devoid of vertical structure), representing an evolutionarily recent phenomenon (barriers to movement). That is, birds have not had sufficient time to adapt to the presence of vertical obstructions in the Gulf of Mexico (Bevanger, 1998; 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 human-induced avian mortality, which are discussed in the cumulative impacts analysis below.

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 3-2 and 3-5**). It is projected that 15-23 production platforms would be installed in the WPA due to a WPA proposed action (**Table 3-2**; but see also **Table 3-5**). It is projected that 290,000-650,000 helicopter operations could occur in the WPA due to a WPA proposed action. This is a rate of 20-41 flights/day or 139-290 flights/week (**Chapter 3.1.1.8**).

Vessel and Air Traffic: It is projected that there will be 64,000-75,000 service-vessel round trips related to a WPA proposed action in the WPA (**Table 3-5**). This represents a rate of 4-5 vessel trips/day or 31-36 vessel trips/week. 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 4.1.1.12.1** 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.

Air Pollution: **Chapters 3.1.1.5 and 4.1.1.1** provide an analysis of the routine effects of the WPA proposed action on air quality (see also above). Emissions of pollutants into the atmosphere from the activities associated with a WPA 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). Impacts to birds from decreased air quality due to routine activities are expected to be negligible because air quality impacts from a WPA proposed action are unlikely to impact ambient air quality.

Produced Water: **Chapters 3.1.1.4 and 4.1.1.2** provide an analysis of the effects of a WPA 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 (**Tables 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 (Fraser et al., 2006). 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 42 mg/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 4.1.1.3.**) concludes that a WPA 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 WPA proposed action, 0-1 new pipeline landfalls and 0-1 new gas processing plants are projected per lease sale (**Tables 3-13, 3-15, 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 as a result of BOEM regulations that prohibit the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). 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 land birds, mostly 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 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 et al., 1990 and 1995; Moore and Aborn, 2000).

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 (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 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 WPA proposed action.

Summary and Conclusion

The majority of the effects resulting from routine activities of the WPA proposed action (**Tables 3-2, 3-4, and 3-5**) 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 4.1.1.12.1**). 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. The addition of 15-23 installed platforms would probably result in the collision death of an additional 750-1,150 birds/year or 30,000-46,000 over the 40-year life of newly installed platforms (**Table 4-7**). This represents an adverse, but not significant, impact to coastal and marine birds. Over the life of the GOM platform archipelago, mortality estimates may be on the order of 7-12 million birds (**Table 4-7**). 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 WPA 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 (WPA) as a result of existing leases and related activities (In the WPA, there are 1,302 active leases, as of November 2011 [USDOI, BOEM, 2011]). Within the WPA, 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 sea turtle 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 WPA 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, FWS and USDOI, MMS, 2009). However, avoidance measures and conditions are routinely placed on permitted activities to protect habitat (**Table 4-2**).

4.1.1.14.3. Impacts of Accidental Events

The impacts of accidental events associated with a WPA proposed action on all marine and coastal birds are expected to be adverse but not significant. The following analysis includes information developed and incorporated in the wake of the DWH event (National Oil Spill Commission, 2011c). Additional information on oil-spill impacts to birds and results from avian monitoring related to the DWH event can be found in **Chapter 4.1.1.14.1**. A more detailed discussion of catastrophic oil-spill events can be found in **Appendix B**. Additional information regarding oil-spill occurrence, probabilities, and volumes for the Gulf of Mexico can be found in Anderson and Labelle (2000), National Oil Spill Commission (2011c), and Ji et al. (in preparation) (**Tables 3-11, 3-12, 3-17, and 3-18**). A summary (last updated December 14, 2010) of birds collected by FWS (USDOI, FWS. 2010a) 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 4.1.1.14.1** and only included direct impacts to avian populations, habitats, and food resources. The USCG (USDHS, CG, 2006) reported 6 major, 5 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 3-24 and 3-25**).

These results and the reviews from the National Oil Spill Commission (2011c, 2011f, 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 WPA proposed action, especially in the event of hurricanes (**Table 3-25 and Figure 3-5**).

Background/Introduction

This section discusses impacts to coastal and marine birds resulting from accidents associated with a WPA 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 4.1.1.14.1 and 4.1.1.14.2**, 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 naphlalene 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).

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 3-9**; see also the "Proposed Action Analysis" below). 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 to the coast ameliorates, to some extent, toxicity at the shoreline.

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 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). The physiology and biochemical network of a bird has a large number of components, interactions, and functions that may provide potential points of attack from petrochemicals (Welty and Baptista, 1988). The network and internal feedback system also provides routes by which an effect on one process can lead to cascading sublethal, chronic effects in other systems (Burger and Fry, 1993; Albers, 2006).

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 semiaquatic 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 and 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) 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. Numerous symptoms were found in dead birds that washed-up onshore and also in birds dying after rehabilitation from the *Prestige* oil spill off the coast of Spain (November 19, 2002) (Balseiro et al., 2005; Pérez-López et al., 2006; Pérez et al., 2008). Final major impacts to European shags (*Phalacrocorax aristotelis*) from the *Prestige* spill probably came in 2003 from a decimated food supply of fish (Velando et al., 2005b). For additional information, see **Chapters 4.1.1.14.1 and 4.1.1.14.2** (**Tables 4-8, 4-12, and 4-13**).

Parsons (1994) provides the following unique before-after data for impacts of a spill on birds. Extensive shoreline and salt marsh were oiled by a January 1990 Exxon spill in the Arthur Kill and Kill van Kull estuaries of New York Harbor. Double-crested cormorants had achieved their maximum population growth by 1991. Productivity of herring gulls remained unchanged by the spill. Most heron populations increased after the spill. The greater black-backed gull population declined. Snowy egrets and glossy ibis used salt marsh and mud flat habitat, some of which was oiled. Black-crowned night heron and glossy ibis had delayed nesting after the spill and, along with snowy egret, showed lower reproductive success after the spill. Reproductive parameters like egg laying and hatching were generally higher than during the chick-rearing period likely attributable to reduced food availability for provisioning chicks. Waterfowl were not affected seriously, except for a short-term decline in mallards. 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 (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, which may negatively impact body condition and survival (e.g., after the *Exxon Valdez*, harlequin ducks [Esler et al., 2000a 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 the information NRDA has collected to date is not publicly available at this time. 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—it cannot be obtained at this time under any circumstances. The BOEM has applied what additional scientifically credible information is available using accepted 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 DWH impacts on all life-history stages of birds. This section on accidental impacts concerns a WPA proposed action only; the DWH event is discussed in relation to bird baseline conditions in the description of the affected environment for birds. Also, this section discusses accidental impacts relative to estimated baseline conditions (**Chapter 4.1.1.12.1**). Although relevant to a discussion of reasonably foreseeable significant adverse impacts, this information is not essential to a reasoned choice among alternatives, given the existing body of scientific evidence related to oil-spill impacts on birds, particularly in the WPA, which was largely removed from most direct impacts of the spill. Although information from the DWH event would be useful, it is not expected to significantly change this existing body of science.

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 WPA at 10- and 30-day probabilities, respectively, as the result of a WPA proposed action over its 40-year life are as follows (**Figures 3-9 and 3-14 through 3-21**):

- 3-5 percent and 7-11 percent for diving birds (**Figure 3-18**);
- 3-5 percent and 7-12 percent for gulls and terns (**Figure 3-16**);
- 3-5 percent and 6-10 percent for shorebirds (**Figure 3-19**);
- 1-2 percent and 4-7 percent for passerines (**Figure 3-21**);
- <0.5 percent (both 10 days and 30 days) for marsh- and wading birds (**Figure 3-19**);
- 2-4 percent and 5-9 percent for waterfowl (**Figure 3-20**);
- 2-4 percent and 5-9 percent for raptors (**Figure 3-15**);
- 1 percent and 2-3 percent for the threatened piping plover (**Figure 3-14**);
- year-round probabilities for western Louisiana are <0.5-1 percent; and

- year-round probabilities for Texas are 5-8 percent and 8-14 percent.

The combined probabilities are all ≤12 percent at 30 days post-spill. For nearly all avian species groups considered regardless of duration (10 days versus 30 days), estimated probabilities for the WPA are lower than the CPA. It is important to note that the OSRA models used to generate spill probabilities does not account for (1) spatial and temporal patterns in avian distribution, (2) species-specific densities, (3) species-specific habitat preferences, (4) relative vulnerabilities to oiling (**Tables 4-8 and 4-12**), or (5) species-specific life history or demography (**Table 4-13 and Figures 4-18 and 4-19**). For additional information on the Oil Spill Risk Analysis considered here, see **Chapters 3.2.1.4 through 3.2.1.7.**

Small coastal spills, pipeline spills, and spills from accidents in navigable waterways (**Tables 3-21 and 3-28**) 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 (50%, n = 182); seabirds (39%, n = 6,003); waterfowl (37%, n = 56); marsh-wading birds (28%, n = 431); passerines (20%, n = 77); shorebirds (17%, n = 98); and raptors (4%, n = 16). 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 WPA, an estimated total of 245-421 spills (spill size range = 0-1.0 bbl to ≥1,000 bbl) could occur as a result of a WPA proposed action (**Table 3-12**). Over the 40-year life of the OCS Program, the mean number of predicted spills is 2.84-3.88 (≥1,000 bbl) and 0.78-1.11 (≥10,000 bbl), respectively (Ji et al., in preparation). The probability or percent chance of a single oil spill (≥1,000 bbl) occurring in the WPA by resource estimate (low; high) are as follows: facilities (3%; 5%); pipelines (9%; 14%); and total (11%; 18%) (**Table 3-19**). The probability of a pipeline spill (n = 1) occurring is roughly three times higher than that for facilities (**Table 3-19**). In the WPA, data from **Table 3-21** suggest that platforms accounted for 37.3 percent of spills versus just 1.7 percent for pipelines (1996-2009). Overall, the cumulative total of all spills (regardless of size) estimated to occur in the WPA (**Table 3-19**) is roughly 3.9-4.5 times lower than the number of estimated spills in the CPA (**Tables 3-20**). From 1996-2009, there were 931 spills in the WPA (**Table 3-21**). In comparison, there were 12,956 spills in the CPA, which is 13.9 times more spills than in the WPA (**Table 3-21**). See **Chapters 3.2.1.2.1-3.2.1.2.5** for additional information.

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;** see also **Figures 4-15 and 4-16**). As of December 14, 2010, 102 avian species totaling 8,066 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, 2010b). In addition, 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 (USDOI, FWS, 2010b). 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 4-18 and 4-19**). Based on a species' recovery potential (**Table 4-13**), it is probable that populations of the northern gannet, common loon, least tern, royal tern, and brown pelican were most severely impacted.

For additional information regarding potential impacts to avian resources in the offshore environment, refer to the DWH discussion in **Chapter 4.1.1.14.1.** 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 related to oil impacts to birds after the *Exxon Valdez* oil spill, and the disparate interpretations of the science were born out in the literature for many years after the spill (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 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 based upon accepted scientific methodologies and approaches.

In the absence of a catastrophic spill, impacts of a WPA 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 the project. 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 WPA should be less than in the CPA due to the following factors: fewer platforms; lower oil-spill probabilities; and much lower numbers of predicted oil spills, particularly pipeline spills over the life of a WPA proposed action (**Tables 3-2, 3-4, 3-5, 3-12, and 3-19**). 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 (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., 2000a; Alonso-Alvarez et al., 2007a), including changes to sexual signaling (Pérez et al., 2010).

Oil-spill impacts on birds from a WPA 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 WPA proposed action. Impacts of oil-spill cleanup from a WPA proposed action are also expected to be adverse but not significant, but they may be negligible depending on the scope and scale of efforts. Significant impacts to coastal and marine birds could result in the event of a catastrophic spill, depending on the timing, location, and size of the spill. For additional information on a catastrophic spill, see **Appendix B**.

4.1.1.14.4. Cumulative Impacts

A detailed impact analysis of the coastal and marine birds for a WPA proposed action can be found in **Chapters 4.1.1.14.1-4.1.1.14.3**. The following is a summary of new information that has become available since the DWH event (National Oil Spill Commission, 2011c). Additional information on oil-spill impacts to birds and results from avian monitoring related to the DWH event can be found in **Chapter 4.1.1.12.1** (see also **Tables 4-8, 4-12 through 4-15**) (USDOI, FWS, 2010a). The incremental contribution of a WPA 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 WPA proposed action and associated activity levels and oil-spill information can be found in **Tables 3-2, 3-5, 3-12, 3-18, and 3-19**. 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 (2005b), 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 Masden et al. (2010) provide thorough reviews regarding cumulative impacts of development (e.g., oil and gas, mining, and wind farms) 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 4.1.1.14.1 and Table 4-14**).

The OCS activities include the following:

- a WPA 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 4.2.1.1.1-4.2.1.1.4**) expected to be released due to a WPA proposed action, as well as from prior and future OCS lease 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). 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. 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. 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 (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 4.1.1.2.1.1-4.1.1.2.2.4; Tables 3-7, 3-8, 3-9, and 3-21**) 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). Degradation of coastal and inshore water quality resulting from factors related to a WPA proposed action, plus those related to prior and future OCS lease 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 4.1.1.14.2**; 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 noted that almost half of the 37 major estuarine systems in the Gulf of Mexico were considered moderately polluted (USDOC, NOAA, 2011a, Figure 54). 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 hypoxia zone 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 United States. The incremental addition related to a WPA proposed action will 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**). 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, 4-12, and 4-13**; see also **Tables 3-11, 3-12, 3-17, 3-18, and 3-19**). 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., Golet 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 245-421 spills could occur due to a WPA proposed action (**Table 3-12**). For facilities, there is a 3-5 percent probability of a ≥1,000 bbl spill as a result of a WPA proposed action (**Table 3-19**). For pipelines, there is a 9-14 percent probability of a ≥1,000 bbl spill as a result of a WPA proposed action (**Table 3-19**). Pipelines are roughly three 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 3-21**; see also Holdway, 2002; Jernelöv, 2010). Outside of a catastrophic event, petroleum spills or releases that result from a WPA proposed action or OCS energy program would be expected to be small, particularly when compared with naturally occurring seeps in the GOM (**Tables 3-8 and 3-9**). 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, 2010b). 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; Figures 4-18 and 4-19**).

Oil-spill impacts on birds from a WPA proposed action are expected to be adverse but not significant due to fewer proposed platforms, landfalls, service vessel and helicopter trips, lower oil-spill probabilities, etc., compared with the CPA.

Structure Lights and Presence

Every spring, millions of migratory landbirds, mostly 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**), acute sublethal stress from energy loss, and increased predation risks. Data supporting the premise that platforms represent suitable stopover habitat for migratory birds are equivocal (**Chapter 4.1.1.14.2**; 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**). Conservatively, a WPA proposed action may increase this level of mortality by 750-1,150 birds/year. 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 human-induced 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).

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) over populated areas and biologically sensitive areas such as wildlife refuges and national parks. However, it is uncertain if these policies or guidelines are strictly adhered to or enforced, and whether these distances are sufficient to eliminate or minimize disturbance-related impacts to birds in these high traffic areas (refer to the routine impacts section). 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 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 4.1.1.14.2** and reviews by Hockin et al. (1992) and Carney and Sydeman (1999). It is anticipated that both service-vessel traffic and helicopter flights in support of OCS activities in the WPA will be less than in the CPA. Therefore, disturbance-related impacts to avian populations should be relatively less in the WPA than in the CPA.

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 WPA 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 WPA 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 the construction of 0-1 pipeline landfalls for a WPA 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 WPA, it is estimated that 237-544 km (147-338 mi) of pipeline would be used, not including the length of pipelines installed in State waters (**Table 3-2**). The estimated length (5,224-12,339 km [3,246-7,667 mi]) of installed pipeline related to OCS activities is dramatically higher over the 40-year life in the WPA (**Table 3-5**). 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 4.1.1.4.1-4.1.1.4.4** for more details regarding the 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. Dahl 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. 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). 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).

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 BOEM regulations (NTL 2007-G03) regarding the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). 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 WPA should be minimal and relatively less than that in the CPA.

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. Avian species are adaptable with ephemeral settling patterns, but the pace with which they can adapt may be too slow compared with the pace with which human-induced 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 4.1.1.4.1-4.1.1.4.4** 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. Dahl 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, mashbird, 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, 2010k).

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; National Oil Spill Commission, 2011c). The incremental increase of oil spills from a WPA proposed action to the total cumulative impacts is also expected to be moderate to 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 hydro-modification 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, which is 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 WPA, disturbance impacts from helicopter traffic and service vessels (**Tables 3-2, 3-5, and 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 moderate (**Chapters 4.1.1.14.1-4.1.1.14.3**).

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 noncosumptive 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 4.1.1.14.1**.

Maintenance and Use of Navigation Waterways

Adverse impacts related to the 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 WPA proposed action. In addition, no new channels will be required for a WPA 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 were 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 Anthopogenic 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 4.1.1.14.2 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 and 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., Pb 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; **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 myriad 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, 2010b). 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, 2010b). 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 4.1.1.14.1**.

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 of sufficient 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 NOAA-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 affects 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., 2007a).

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 WPA 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 to other habitat, 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) result in collision-related mortality of 200,000-321,000 birds/year (**Table 4-7**); these numbers will increase as a result of a WPA 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 human-induced mortality, represents a small fraction compared with other sources of human-induced mortality. 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 ~8,000 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 WPA were far less than impacts to the avian community in the CPA. 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 effects to birds, including from the DWH event (and thus changes to the birds baseline in the affected environment), makes an understanding of the cumulative effects less clear; although as noted above, most species in the WPA were likely unaffected based on the lateral extent of the plume, residency periods, and migration patterns. Here, BOEM concludes that the unavailable information from this event may be relevant to foreseeable significant adverse impacts to birds. Relevant data on the status of seabird 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 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 based upon accepted methods and approaches. 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 an Action alternative) for the following reasons. There are 1,302 active leases (as of November 2011) in the WPA with ongoing (or the potential for) exploration, drilling, and production activities (USDOI, BOEM, 2011). In addition, non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA 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. Impacts on birds from either smaller accidental events or low-probability catastrophic events will remain the same. And as noted above, the oil plume from the DWH event remained east of the WPA boundary, and impacts to birds in the WPA were likely negligible.

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- 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, 2010b), 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 WPA proposed action to the cumulative impact is considered adverse but not significant when compared with the impacts of non-OCS Program-related factors.

4.1.1.15. Fish Resources and Essential Fish Habitat

The full analyses of the potential impacts of routine activities and accidental events associated with a WPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in **Chapters 4.1.1.15.2 and 4.1.1.15.3**. A brief summary of potential impacts follows. Fish resources and essential fish habitat (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 EFH. 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 fish resources and EFH include blowouts and oil or chemical spills. A subsurface blowout would have a negligible effect on Gulf of Mexico fish resources because the probability of the event is rare and would affect a small portion of fish populations. If spills due to a WPA 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 due to the capability of adult fish and shellfish 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 WPA 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 WPA proposed action to the cumulative impacts on fisheries and EFH would be small.

4.1.1.15.1. Description of the Affected Environment

Background/Introduction

Fish resources of the Gulf of Mexico consist of a large diverse group of families and species. The fish resources range from estuarine-dependent species to the bathypelagic species. Also included are migratory species, such as the bluefin tuna, that spend only a part of their life cycle in the Gulf. The following is a summary of these groups.

Ichthyoplankton

Most fishes inhabiting the GOM, whether benthic or pelagic as adults, have pelagic larval stages. For various lengths of time (10-100 days depending on the species), these pelagic eggs and larvae become part of the planktonic community. Variability in survival and the transport of pelagic larval stages is thought to be an important determinant of future year-class strength in adult populations of fishes and invertebrates (Underwood and Fairweather, 1989; Doherty and Fowler, 1994). In general, the distribution of fish larvae depends on the spawning behavior of adults, hydrographic structure and transport at a variety of scales, duration of the pelagic period, behavior of larvae, and larval mortality and growth (Leis, 1991). Larval fishes are highly dependent on zooplankton until they can feed on larger prey.

In 1982, the first comprehensive surveys of the Southeastern Area Monitoring and Assessment Program (SEAMAP) began collecting larval fishes in the GOM from a grid of sampling stations encompassing the entire northern GOM. Since SEAMAP's inception, the goal of plankton activities in the GOM has been to collect data on the early life stages of fishes and invertebrates that will complement and enhance the fishery independent data gathered on the adult life stage. This continuing survey remains the only major effort to sample ichthyoplankton on a Gulfwide basis. Plankton samples are taken at stations arranged in a systematic grid across the GOM. An annual larval index for the Atlantic bluefin tuna is generated each year from the spring survey and is used by the International Commission for the Conservation of Atlantic Bluefin Tunas to estimate stock size. The objective of the fall survey is to collect ichthyoplankton samples with bongo and neuston gear for the purpose of estimating abundance and defining the distribution of eggs, larvae, and small juveniles of GOM fishes, particularly king and Spanish mackerel, lutjanids and sciaenids.

The accumulating SEAMAP data have not been synthesized on a regular basis. There are some examples of data synthesis for specific areas. Lyczkowski-Shultz et al. (2004) synthesized SEAMAP data between 1982 and 1999 for a localized area in the northeastern GOM (NEGOM) including the De Soto Canyon. Comparison of the NEGOM area with the overall SEAMAP survey area of the entire northern Gulf revealed that the larvae of 16 taxa occurred more frequently and were relatively more abundant in the NEGOM area than the entire SEAMAP survey area, while for other taxa, occurrence and relative abundance were comparable. These taxa represented fishes from mesopelagic, continental shelf, and reef assemblages, and the authors concluded that they reflected the wide diversity of habitats available in the NEGOM. Distinct distribution patterns were observed among larvae in the NEGOM study area that appear to be associated with the presence of the De Soto Canyon, as well as proximity to the influence of input from the Mississippi River.

Lyczkowski-Shultz et al. (2000) examined Gulf SEAMAP data from surveys in 1982 to 1995 for only young beryciform fishes, 1 of 42 orders of teleost fishes including the soldierfishes, squirrelfishes, roughies, flashlight fishes, and others. This analysis yielded new insights into the early life history of these unusual, rarely collected fishes. The squirrelfishes and soldierfishes (family Holocentridae) were the most numerous group. Nearly as numerous were the young of the bigscales (family Melamphaidae). Only a few specimens were observed in each of the remaining four families: Polymixiidae, Diretmidae, Trachichthyidae, and Gibberichthyidae.

The most recent analysis of SEAMAP data was done by LGL Ecological Research Associates (2009) for the Offshore Operators Committee. The study divided the northern GOM into 15 sections and analyzed SEAMAP data from 1982 to 2004 for spawning depth, range of habitat, and spawning seasonality for the major commercial and recreational species. In general, the finding was that the greatest concentration of key marine species including their spawning habitat is restricted to the continental shelf in water depths <200 m (656 ft).

Some independent ichthyoplankton studies have been conducted, focusing specifically on the influence of offshore platforms. The first comprehensive project was an Agency-funded study by Hernandez et al. (2001) that sampled three platforms as well as a nearshore rock jetty. A follow-up study, also funded by this Agency, by Shaw et al. (2002) looked at several platforms both east and west of the Mississippi River Delta. Both Hernandez et al. (2001) and Shaw et al. (2002) found highest taxonomic richness and diversity at mid-shelf platforms. Larval and juvenile fish assemblages seemed to be influenced by across-shelf gradients of increasing depth. Reef taxa were most abundant and diverse at the mid-shelf platforms, primarily because of the large numbers of larval and juvenile blenniids, pomacentrids, and lutjanids. This high abundance and diversity at mid-shelf could be attributed to the high concentration of platforms (i.e., more potential sources of larvae) and the favorable environmental conditions at mid-shelf (Gallaway, 1981; LGL Ecological Research Associates, Inc. and Science Applications International Corporation, 1998; Tolan, 2001). The only differences observed by Shaw et al. (2002) in the larval and juvenile fish assemblages across longitudinal gradients (i.e., east or west of the Delta) were differences in the abundance of certain taxa. Higher abundance of these taxa east or west of the Delta may, in turn, reflect differences in the hydrographic conditions and/or habitat availability. Despite the higher concentration of natural reef-type habitats east of the Delta, reef larvae were not more abundant at platforms in these areas.

Two of the most important hydrographic features in the GOM are the Mississippi River discharge plume and the Loop Current. In the case of the river plume, hydrodynamic convergence and the continually reforming turbidity fronts associated with the discharge plume probably account for the concentration of larval fishes at the front. Frontal waters in both the river plume and eddy boundaries provide feeding and growth opportunities for larvae. Recent work has focused on hydrographic features that appear to concentrate the biomass of a variety of size scales from phytoplankton to megafauna. Biggs and Ressler (2002) describe deepwater “hot spots” of zooplankton, micronekton, and ichthyoplankton when primary production is enhanced by coarse to mesoscale eddies. Lamkin (1997) also showed that larval fish were associated with the Loop Current and periphery regions of companion cyclones and anticyclones, and Wormuth et al. (2000) documented that deepwater cyclones had locally higher standing stocks of zooplankton and micronekton but only in the upper 100 m (328 ft) of the water column.

Fishes

The Gulf of Mexico supports a great diversity of fish. Distributions of fish species are dependent on a variety of ecological factors, including 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. Many of the fishes that inhabit the shelf are dependent on estuaries at some point in their life cycle. Many important commercial species spend their juvenile phases in the estuaries of the Gulf of Mexico. Because of the variety of habitats, almost the entire GOM is within a designated EFH.

Estuaries and rivers of the GOM export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas. From the shoreline to a depth of about 20 m (66 ft), the fish fauna is dominated by sea catfishes (Ariidae), lizardfishes (Synodontidae), and sciaenids (drums, seatrout, kingfish, and others) (McEachran and Fechhelm, 1998). These fish are very dependent on estuaries as nursery grounds. Gulf menhaden and members of the Sciaenidae family such as croaker, red and black drum, and spotted sea trout are directly dependent on estuaries during various phases of their life history. The occurrence of dense schools, generally by members of fairly uniform size, is an outstanding characteristic that facilitates mass production methods of harvesting menhaden. The seasonal appearance of large schools of menhaden in the inshore Gulf waters from April to November dictates the menhaden fishery (Nelson and Ahrenholz, 1986). Larval menhaden feed on pelagic zooplankton in marine and estuarine waters. Juvenile and adult Gulf menhaden become filter-feeding omnivores that primarily consume phytoplankton but also ingest zooplankton, detritus, and bacteria. As filter-feeders, menhaden form a link between estuarine and marine food webs and, in turn, are prey for many species of larger fish (Vaughan et al., 1988). An additional excellent source of fisheries information for both fish and invertebrate species in GOM estuaries can be found in Pattillo et al. (1997)

Out to a depth of 40-50 m (131-164 ft), on muddy bottoms, the fish fauna is dominated by porgies (Sparidae), batfishes (Ogcocephalidae), sea-robins (Triglidae), sea basses (Serranidae), and left-eyed flounders (Bothidae). These species are also largely dependent on estuaries as nursery grounds. On shell or hard bottoms in the same depth range (20 to 40 or 50 m; 66 to 131 or 164 ft), a slightly different species group occurs, which is dominated by snappers (Lutjanidae) and other spiny-rayed fishes with a preference for hard substrate (McEachran and Fechhelm, 1998).

Other reef fish species are considered nonestuary dependent, such as the red snapper, which remains close to underwater structure for at least their early years. Recent research has shown that oil and gas platforms play a substantial role in providing habitat to red snapper through the first 2-5 years of life (Peabody and Wilson, 2006; Wilson et al., 2003). Red snapper feed along the bottom on fishes and benthic organisms such as crustaceans and mollusks. Peabody and Wilson (2006) clearly demonstrated the diurnal feeding movements of red snapper moving away from platforms at night to feed on surrounding bottom areas and then returning during the day. Juveniles feed on zooplankton, small fish, crustaceans, and mollusks (Bortone and Williams, 1986; USDOC, NOAA, 1986).

Thirteen banks have been identified by the Gulf of Mexico Fisheries Management Council as being important features in the northwestern GOM, and these banks are designated as habitat areas of particular concern. Topographic features on the mid- to Outer Continental Shelf include a wide range of habitat types and fish communities. The most diverse are located at the shelf edge where water quality and temperature allow for the development of coral reef assemblages. The two most spectacular examples are the East and West Flower Garden Banks, thriving coral reefs that come to within 18 m (59 ft) of the sea surface from a surrounding bottom of 100-130 m (328-427 ft) deep. The fish assemblage at the Flower Garden Banks has been documented in several studies; the most comprehensive is in Boland et al. (1983), extending from the reef crest to soft-bottom habitat and resulting in a total of 357 hours of survey video. Analysis of that data resulted in a total of 141 separate fish taxa, in some cases not identified to the species level from visual evidence alone. Boland et al. (1983) separated habitat types into eight categories and determined fish abundance for each. The reef crest was dominated by the creolefish (*Paranthias furcifer*) with densities as high as 210 per 1,000 m^2 (10,764 ft^2) Total standing stock determinations were also made for 16 reef fish taxa in Boland et al. (1983). Other abundant species on the East and West Flower Garden Banks' coral caps include creole wrasse, blue and brown chromis, several species of parrot fish, and several damselfish species. An early account of the fish assemblage at the Flower Garden Banks appears in Bright and Cashman (1974), where a total of 101 fish species were reported. In more recent surveys that were performed by divers, a total of 117 fish species were seen by the survey teams at the East and West Flower Garden Banks (Pattengill-Semmens et al., 2000).

The remaining OCS, to a depth of approximately 200 m (656 ft), generally has a muddy or silty soft bottom. Fishes dominating this habitat include hakes (Phycidae), scorpionfishes (Scorpaenidae), and ogcocephalids (batfishes) (McEachran and Fechhelm, 1998). In this region where hard bottom occurs, some of the reef fish species that occur on the upper shelf can also be found. In addition, some species, including snowy grouper, warsaw grouper, yellowedge grouper, and gag, are particularly adapted for deeper hard-bottom areas.

Deepwater demersal fishes below several hundred meters of depth are better known than the deep pelagic species. Three major deep-sea studies have collected demersal fish throughout the depth range of the Gulf's continental slope between the 1960's and as recently as 2003. The first comprehensive look at the deeper part of the Gulf was by a long series of cruises by Pequegnat between 1964 and 1973 (Pequegnat, 1983). Pequegnat reported a total of 206 demersal fish species within 47 families. The Macrouridae (rattails) was the most speciose family, represented by 30 species, followed by Ophidiidae (cusk-eels) with 23 species. Gallaway et al. (1988) trawled 60 continental slope stations ranging in depth from 278 m to nearly 3,000 m (912 to 9,843 ft), collecting a total of 5,400 fishes and 126 species. Only five species were represented by more than 300 specimens; the Atlantic batfish (*Dibranchus atlanticus*) was the most common. The other four most abundant included a hake (*Urophycis cirratus*), the flathead (*Bembrops gobiodes*), the cutthroat eel (*Synaphobranchus oregoni*), and the rattail (*Chlorophthalmus agassizi*). These same stations were also photographed by a still camera system; the two techniques showed significant differences, indicating an undersampling by standard trawling techniques. The densities of fish determined from photography exceeded that estimated from trawling at all but one station by as much as one or two orders of magnitude. The mean density of fish determined from photography was 198.5 per hectare (1 ha = 10,000 m^2 [107,639 ft^2]).

A second large, Agency-funded deepwater study was completed in 2006. Rowe and Kennicutt (2009) also sampled a wide range of depths throughout the northern GOM and also several stations in Mexican waters. Trawling for demersal fishes was conducted during the 2000, 2001, and 2003 surveys of the study; however, the only comprehensive survey occurred in the 2000 survey. During the 2000 survey, fishes were captured at 31 of the 43 stations representing all of the deep Gulf of Mexico benthos transects, ranging in depths from 188 to 3,075 m (617 to 10,089 ft). A total of 1,065 individual demersal fishes, representing 119 species and 42 families, were collected in the 31 trawl collections. The families Macrouridae (grenadiers or rattails) with 21 species, Ophidiidae (cuskeels) with 15 species, and Alepocephalidae (slickheads) with 8 species dominated the samples. Cluster analyses resulted in four major assemblages. These consisted of an OCS assemblage between 188 and 216 m (617 and 709 ft), an upper slope assemblage between 315 and 785 m (1,033 and 2,575 ft), a mid-slope assemblage between 686 and 1,369 m (2,251 and 4,491 ft), and a deep assemblage between 1,533 and 3,075 m (5,030 and 10,089 ft).

Recruitment is by far the most important, yet the least understood, factor contributing to changes in the numbers of harvestable Gulf fish. Natural phenomena such as weather, hypoxia, and red tides may reduce standing populations. Studies of abundance, growth, and mortality that affect recruitment have demonstrated the difficulty in making estimates over time or comparing different areas. As an example, Scharf (2000) examined red drum data from nine estuaries along the Texas Gulf Coast during a 20-year period and determined that estimates of abundance and mortality exhibited order-of-magnitude differences. Variations were also not related among estuaries, suggesting that factors affecting the survival of young red drum were specific to individual estuarine systems.

Pelagics

Pelagic fishes occur throughout the water column from the beach to the open ocean. Water-column structure (temperature, salinity, and turbidity) is the only partitioning of this vast habitat. On a broad scale, pelagic fishes recognize different watermasses based upon physical and biological characteristics. Some sources divide pelagic waters into three subdivisions by depth: the epipelagic from the surface to a depth of 200 m (656 ft); the mesopelagic from 200 to 1,000 m (656 to 3,281 ft); and the bathypelagic below 1,000 m (3,281 ft). The epipelagic is then divided into the coastal and oceanic, the first overlying the continental shelf and the oceanic representing the area seaward of the shelf (McEachran and Fechhelm 1998). Four ecological groups will be presented individually here, delineated by watermass:

- coastal pelagic species;
- oceanic pelagic species;
- mesopelagic species; and
- bathypelagic species.

For coastal pelagic fishes, commercial fishery landings are one of the best sources of information because these species are an important component of nearshore net and hook-and-line fisheries. Some smaller nektonic fishes occupying the surf zone along exposed beaches have been collected with seines (Naughton and Saloman, 1978; Ross, 1983). Information on the distribution and abundance of oceanic species comes from commercial longline catches and recreational fishing surveys. In addition, NMFS has conducted routine surveys of the GOM billfishery since 1970 (Pristas et al., 1992). Mesopelagic species are not harvested commercially but have been collected in special, discrete-depth nets that provide some quantitative data on relative abundance (Bakus et al., 1977; Hopkins and Lancraft, 1984; Gartner et al., 1987; Sutton and Hopkins, 1996).

Coastal Pelagics (Epipelagic)

Coastal pelagic species traverse shelf waters of the region throughout the year. The major coastal pelagic families occurring in the region are Carcarhinidae (requiem sharks), Elopidae (ladyfish), Engraulidae (anchovies), Clupeidae (herrings), Scombridae (mackerels and tunas), Carangidae (jacks and scads), Mugilidae (mullets), Pomatomidae (bluefish), and Rachycentridae (cobia). The distribution of most species depends upon water-column structure, which varies spatially and seasonally. Some coastal pelagic species show an affinity for vertical structure and are often observed around natural or artificial structures, where they are best classified as transients rather than true residents. Some species form large schools (e.g., Spanish mackerel), while others travel singly or in smaller groups (e.g., cobia). King mackerel in the GOM exist in two populations, an eastern group and a western group. The eastern population migrates from near the Mississippi Delta eastward, then southward around the Florida Peninsula, wintering off southeastern Florida (Sutter et al., 1991). The western population travels to waters off the Yucatan Peninsula during winter. In summer, both populations migrate to the northern GOM, where they intermix to an unknown extent. Spanish mackerel, cobia, bluefish, jack crevalle, and coastal sharks are migratory, but their routes have not been studied.

Coastal pelagic fishes can be divided into two ecological groups. The first group includes large predatory species such as king and Spanish mackerels, bluefish (*Pomatomus saxatilis*), cobia, jacks (*Caranx* spp.), and little tunny (*Euthynnus alletteratus*). These species typically form schools, undergo migrations, grow rapidly, mature early, and exhibit high fecundity. Each of these species is important to some extent to regional fisheries. The second coastal pelagic ecological group exhibits similar life history characteristics, but the species are smaller in body size and are planktivorous. This group is composed of anchovies (*Anchoa* spp.), Gulf menhaden (*Brevoortia patronus*), round scad, Spanish sardine, striped mullet (*Mugil cephalus*), and thread herring (*Opisthonema oglinum*). Species in the second group are preyed upon by the larger species in the first group; thus, the two are ecologically important in energy transfer in the nearshore environment.

Some coastal pelagic species are found along high-energy sandy beaches from the shoreline to the swash zone (Ross, 1983). An estimated 44-76 species, many of them coastal pelagics, occur in the surf zone assemblage. Larger predatory species (particularly bluefish, Spanish mackerel, and blue runner) may be attracted to large concentrations of anchovies, herrings, and silversides that congregate in the surf zone.

Commercial purse seine fisheries generate high landings of several coastal pelagic species in the region. The Gulf menhaden fishery produces the highest fishery landings in the United States (USDOC, NMFS, 2011f). Menhaden form large, surface-feeding schools in waters near the Mississippi Delta from April through September. Fishermen take advantage of this schooling behavior, capturing millions of pounds each year with large purse nets (total for 2009 Gulfwide was 1,220,566,613 lb). Other coastal pelagic species contributing high commercial landings are Atlantic thread herring, Spanish sardine, and ladyfish. Most of the large-bodied, predatory coastal pelagic species are important to commercial or recreational fisheries. King and Spanish mackerel, cobia, and jacks are sought by the charter and head-boat fisheries in the region. 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.

Oceanic Pelagics (Epipelagic)

Common oceanic pelagic species include tunas, marlins, sailfish, swordfish, dolphins, wahoo, and mako sharks. In addition to these large predatory species, there are halfbeaks, flyingfishes, and driftfishes

(Stromateidae). Lesser-known oceanic pelagics include opah, snake mackerels (Gempylidae), ribbonfishes (Trachipteridae), and escolar. The lower section of this epipelagic/oceanic pelagic zone has a distinct fauna, consisting of the poorly known oarfishes and relatives, in addition to fishes with great depth ranges such as Scombridae (tunas) and Xiphiidae (swordfishes) (McEachran and Fechhelm, 1998).

Oceanic pelagic species occur throughout the GOM, especially at or beyond the shelf edge. Oceanic pelagics are reportedly associated with mesoscale hydrographic features such as fronts, eddies, and discontinuities. Many of the oceanic fishes also associate with drifting *Sargassum*, which provides forage areas and/or nursery refugia. Fishermen contend that yellowfin tuna aggregate near sea-surface temperature boundaries or frontal zones; however, Power and May (1991) found no correlation between longline catches of yellowfin tuna and sea-surface temperature (defined from satellite imagery) in the Gulf of Mexico. Other sorts of frontal zones such as “tide lines” are well known for attracting some species such as dolphin (*Coryphaena hippurus*). Offshore platforms in deep water have recently been identified as significant attraction devices for tuna, especially yellowfin (Edwards et al., 2002). There are a total of 64 structures currently operating in the GOM in water depths of 1,300 ft (396 m) or greater. The occurrence of bluefin tuna larvae in the GOM that are associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that this species spawns in the GOM (Richards et al., 1989). Block et al. (2001) also reported on the GOM being used as a breeding ground and demonstrated trans-Atlantic migrations of bluefin tuna between the eastern Mediterranean, Atlantic, and Gulf of Mexico using electronic data storage tags. The North Atlantic bluefin tuna has its peak spawning period in April and May in the Gulf.

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. 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).

Mesopelagics

The mesopelagic realm is below the photic zone and below the permanent thermocline. Mesopelagic fish assemblages in the GOM are numerically dominated by myctophids (lanternfishes), with gonostomatids (bristlemouths) and sternoptychids (hachetfishes) common but less abundant in collections. These fishes make extensive vertical migrations during the night from mesopelagic depths (200-1,000 m; 656-3,281 ft) to feed in higher, food rich layers of the water column (McEachran and Fechhelm, 1998). Mesopelagic fishes are important ecologically because they transfer substantial amounts of energy between mesopelagic and epipelagic zones over each diel cycle.

Sutton and Hopkins (1996) investigated the trophic ecology of the stomiid assemblage (Stomiidae; dragonfishes and viperfishes) in the eastern GOM. Over 1,400 specimens representing 69 species and 17 genera were examined. Four patterns of feeding were evident among the abundant stomiids: (1) myctophid predation; (2) zooplankton/small micronekton predation; (3) penaeidean shrimp predation; and (4) copepod/micronekton predation. Lanternfishes were found to feed mostly on crustacean zooplankton (copepods) (Hopkins and Gartner, 1992).

Lanternfishes were most common in the catches made by Bakus et al. (1977) and Hopkins and Lancraft (1984). Gartner et al. (1987) collected 17 genera and 49 species of lanternfish in trawls fished at discrete depths from stations in the south, central, and eastern Gulf. Lanternfishes generally spawn year-round, with peak activity in spring and summer (Gartner, 1993). The most abundant species in decreasing order of importance were *Ceratoscopleus warmingii*, *Notolychus valdiviae*, *Lepidophanes guentheri*, *Lampanyctus alatus*, *Diaphus dumerili*, *Benthosema suborbitale*, and *Myctophum affine*.

Bathypelagics

The deeper dwelling bathypelagic fishes inhabit the water column at depths >1,000 m (3,281 ft) and seldom migrate into shallower waters. This zone receives no sunlight and temperatures range from 4°C to 10°C (39°F to 50°F). Deep-sea angler fishes (Ceratioidei) dominate this realm in most seas, but they are poorly known from the GOM (McEachran and Fechhelm, 1998). Numerous species of gonostomatids (bristlemouths or lightfishes) and scaleless black dragonfishes (Melanostomiidae) are found in the bathypelagic of the Gulf. There are 4 orders, 13 families, and 49 species known for the GOM. Like mesopelagic fishes, most species are capable of producing and emitting light (bioluminescence) to aid in communication in an environment devoid of sunlight (Snyder, 2000).

Stock Status of Fishes of the Gulf of Mexico

Commercial and recreational fish stocks managed by the Gulf of Mexico Fisheries Council are listed and categorized by habitat in **Appendix D**. Of those species managed, four are listed as overfished (USDOC, NMFS, 2011f): 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.

Gag grouper, reef fish that are found Gulfwide, is a popular commercial and recreational fish. Commercial catch of the gag decreased from approximately 515,000 lb in 1990 to 74,000 lb in 2009. Gags travel to specific areas to spawn in groups. After spawning, the largest fish will turn into males. Male gags are aggressive feeders and, once located, they are easy to catch. By the 2000's, under 5 percent of the populations was male, causing some fisheries managers concern that not enough males are present to fertilize the females' eggs (Horst and Lane, 2007).

Greater amberjack also found near reefs and wrecks Gulfwide from nearshore to depth >300 ft (91 m). Commercial catch has varied over the years 2000-2009 from a high in 2004 of 1.13 million pounds to a low of 851 thousand pounds in 2008 (USDOC, NMFS, 2011f). Amberjacks are large (up to 175 lb) and are voracious feeders (Horst and Lane, 2007). Commercially, they are generally caught by longline gear.

Red snapper are considered reef fish (reefs, wrecks, oil platforms) and are highly popular commercial and recreational fish. The commercial catch between 2000 and 2009 varied from a high of 13.2 million pounds in 2006 to 7.9 million pounds in 2008 and 2009 (USDOC, NMFS, 2011f). Although fish are removed by commercial and recreational fishers, most fish are removed in the 0-1 year class by the shrimp fishery. At the red snapper workshop held in April 2004 by the Gulf of Mexico Fishery Management Council (GMFMC, 2004a), the combined recreational and commercial red snapper take was roughly 3-4 million red snapper annually, with the shrimp fishery bycatch removing roughly 25-45 million red snapper annually.

Gray triggerfish are also found near reefs, wrecks, and oil platforms Gulfwide. Over the last 10 years, triggerfish landings have been a high in 2003 at 92.2 thousand pounds and a low in 2009 at 19.3 thousand pounds. Until recently, the gray triggerfish was not considered a desirable catch. The Stock Assessment (Valle et al., 2001) suggested that the decline in red snapper and grouper made this reef fish a more desirable catch.

Managed Species

In the first Generic Amendment (GMFMC, 1998), the Gulf of Mexico Fishery Management Council described EFH for the following species. These species or species complexes are brown shrimp (*Farfantepenaeus aztecus)*, pink shrimp (*Farfantepenaeus duorarum)*, white shrimp (*Litopenaeus setiferus*), royal red shrimp (*Pleoticus robustus*), red drum (*Sciaenops ocellata*), black grouper (*Mycteroperca bonaci*), red grouper (*Epinephelus morio*), gag (*Mycteroperca microlepis*), scamp (*Mycteroperca phenax*), red snapper *(Lutjanus campechanus*), gray snapper (*Lutjanus griseus*), yellowtail snapper (*Ocyurus chrysurus*), lane snapper (*Lujanus syngagris*), vermilion snapper (*Rhomboplites aurorubens*), gray triggerfish (*Balistes capriscus*), greater amberjack (*Seriola dumerili*), lesser amberjack (*Seriola fasciata*), tilefish (Branchiostegidae), king mackerel (*Scomberomorus cavalla*), Spanish mackerel

(*Scomberomorus maculatus*), bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum*), dolphin (*Coryphaena hippurus*), little tunny (*Euthynnus alleteratus*), stone crab (*Menippe spp*.), spiny lobster (*Panulirus spp*.), and coral (Anthozoa). The current number of fish species included in Fishery Management Plans (FMP's) is a larger total of 54. All of these species are listed in **Table 4-16**. The additional numbers come primarily from additional snapper, grouper, and tilefish species in the Reef Fish FMP (43 total). Many of these managed species do not occur or very rarely occur in the WPA and CPA boundaries. None of the fish stocks managed by the GMFMC are endangered or threatened, although two *Acropora* coral species were listed as threatened in 2006 (*Federal Register*, 2006d). There are only two known living coral colonies of *Acropora* in the entire northern GOM: one on the East Flower Garden Bank and one on the West Flower Garden Bank. One grouper species, the Nassau, is "protected" in that it is listed as a species of concern and harvest is prohibited. The goliath grouper was removed from the species of concern list in March 2005.

Detailed presentations of species abundance, life histories, and habitat associations for all life history stages are presented in the Generic Amendment for Essential Fish Habitat by the GMFMC (1998). However, a great deal of new information has appeared since the publication of the first 1998 Amendment. Amendment 3 (GMFMC, 2005) contains substantial new information for all 54 managed species

The Gulf of Mexico was reviewed for the occurrence of EFH for the species above. Essentially all of these species were determined to have at least one life history stage occurring in or near the WPA and CPA. The GMFMC (2004b) did not indicate EFH for spiny lobster (*Panulirus spp*.) or yellowtail snapper (*Ocyurus chrysurus*) in the WPA and CPA, but both species are known to occur on topographic features such as the Flower Garden Banks and Sonnier Bank in the CPA.

Tuna (Scombridae), billfish (Istiophoridae), swordfish (Xiphiidae), and sharks (Squaliformes) are under the direct management of NMFS and are not included as Fishery Management Council managed species. The EFH areas for these highly migratory species (HMS) are described in Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan (USDOC, NOAA, 2010m). The managed species include albacore tuna (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), bluefin tuna (*Thunnus thynnus*), skipjack tuna (*Euthynnus pelamis*), yellowfin tuna (*Thunnus albacares*), swordfish (*Xiphias gladius*), a suite of 32 shark species (Squaliformes), and billfish (Istiophoridae) species, including the blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), sailfish *Istiophorus platypterus*), and longbill spearfish (*Tetrapturus pfluegeri*).

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 Endangered Species Act.

As in the case with shark species, it is difficult to define the habitat of sharks of this temperate zone in the GOM because most species are highly migratory, using diverse habitats in apparently nonspecific or poorly understood ways.

Similar to the species managed by the GMFMC described above, the occurrence of these 14 species managed by NMFS along with major prey species, is discussed in **Appendix D**.

Most, if not all 14 highly migratory species occur beyond the 100-fathom (600-ft, 183-m) water depth contour now identified as the Gulf of Mexico EFH for GMFMC managed species. Many of these highly migratory species such as billfishes are associated with upwelling areas where canyons cause changes in current flow (upwelling) and create areas of higher productivity.

Recent Factors Affecting WPA Fish Populations

Hurricanes

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. Hurricane damage sustained by the fisheries in Galveston Bay as a result of Hurricane Ike, with emphasis on the oyster infrastructure, is document by Haby et al. (2009). This report estimates losses in excess of $31 million including private leases, docks, fuel systems, plants, and inventories in the oyster industry alone, although docks and fuel systems often serve multiple commercial as well as recreational fisheries.

Essential Fish Habitat

Essential fish habitat (EFH) is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Habitat areas of particular concern (HAPC) are localized areas of EFH that are ecologically important, sensitive, stressed, and/or a rare area as compared with the rest of a species' EFH geological range. Examples of HAPC's, as designated by GMFMC in the vicinity of the WPA, are portions of the Flower Garden Banks. The NMFS has a poster outlining many of these banks; it can be found on their website at http://sero.nmfs.noaa.gov/hcd/pdfs/efhdocs/gom_efhhapc_poster.pdf (*Federal Register*, 2006d). 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, stone crabs, spiny lobsters, coral and coral reefs, and highly migratory species (GMFMC, 2004b; 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 WPA are discussed in various chapters of this EIS: water column (**Chapter 4.1.1.2**), wetlands (**Chapter 4.1.1.4**), seagrass communities (**Chapter 4.1.1.5**), topographic features (**Chapter 4.1.1.6**), *Sargassum* (**Chapter 4.1.1.7**), chemosynthetic deepwater benthic communities (**Chapter.1.1.8**), nonchemosynthetic deepwater benthic communities (**Chapter 4.1.1.9**), and soft-bottom benthic communities (**Chapter 4.1.1.10**); 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 2.3.1.3.1, 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 the 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 the proposed action; and (4) analysis of the effects of the proposed and cumulative actions on EFH, the managed species, and associated species. This Agency entered into a Programmatic Consultation agreement with NMFS on July 1, 1999, for petroleum development activities in the WPA. 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. A biological assessment, which includes summaries of the proposed action, impacts, and relevant NTL's; descriptions of managed species and EFH's; and the recommendations from NMFS with the responses from BOEMRE 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 (exploration, drilling, development, production, pipeline, etc.) 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**).

Addressing Essential Fish Habitat Requirements.

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 general recommendations for State waters and wetlands are as follows:

(1) Exploration and production activities should be located away from environmentally sensitive areas such as oyster reefs, wetlands, seagrass beds, endangered species habitats, and other productive shallow water areas. Use of air boats instead of marsh buggies should be implemented whenever possible.

(2) Upon cessation of drilling or production, all exploration/production sites, access roads, pits, and facilities should be removed, backfilled, plugged, detoxified, revegetated, and otherwise restored to their original condition.

(3) A plan should be in place to avoid the release of hydrocarbons, hydrocarbon-containing substances, drilling muds, or any other potentially toxic substance into the aquatic environment and the surrounding area. Storage of these materials should be in enclosed tanks whenever feasible or, if not, in lined mud pits or other approved sites. Equipment should be maintained to prevent leakage. Catchment basins for collecting and storing surface runoff should be included in the project design.

The *Generic Amendment* (GMFMC, 1998) 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. These recommendations are as follows:

(1) Drill cuttings should be shunted through a conduit and discharged near the seafloor, or transported ashore, or to less sensitive, NMFS -approved offshore locations.

(2) Drilling and production structures, including pipelines, generally should not be located within one mile of the base of a live reef.

(3) All pipelines placed in waters less than 300 ft (91 m) deep should be buried to a minimum of 3 ft (1 m) beneath the seafloor, where possible. Pipeline alignments should be located along routes that minimize damage to marine and estuarine habitat. Buried pipelines should be examined periodically for maintenance of adequate earthen cover.

(4) In anchorage areas, all abandoned structures must be cut off 25 ft (8 m) below the mud line. If explosives are to be used, NMFS should be contacted to coordinate marine mammal and endangered species concerns.

(5) All natural reefs and banks, as well as artificial reef areas, should be avoided.

The 1998 *Generic Amendment* makes an additional specific recommendation regarding OCS oil and gas activities under review and permit authority by this Agency and USEPA. Specifically, for the conservation of EFH, activities should be conducted so that petroleum-based substances such as drilling mud, oil residues, produced waters, or other toxic substances are not released into the water or onto the seafloor.

The most recent Generic Amendment 3 (GMFMC, 2005) also included comments regarding oil and gas exploration and production activities on the continental shelf. Item Nos. 1, 2, and 5 above were the same as in the previous 1998 Amendment. Item No. 3 was altered to read "waters less than 200 ft" (61 ft) for burial of pipelines as opposed to 300 ft (91 m) before and also adding "Where this is not possible and in deeper waters where user-conflicts are likely, pipelines should be marked by lighted buoys and/or lighted ranges on platforms to reduce the risk of damage to fishing gear and the pipelines." Also, Item No. 5 above was altered in 2005 to read "15 ft below the mud line" for structure removal as opposed to 25 ft (8 m) indicated before. The changes to these two items now reflect the actual policy that this Agency has historically followed.

The BOEM lease sale stipulations and regulations already incorporated many of the suggested EFH conservation recommendations. Lease sale stipulations are considered to be a normal part of the OCS operating regime in the GOM. Compliance with stipulations from lease sales is not optional; application of a stipulation(s) is a condition of the lease sale. In addition, BOEM may attach mitigating measures to an application (exploration, drilling, development, production, pipeline, etc.) and issue an NTL.

The BOEM's Topographic Features and Live Bottom (Pinnacle Trend) Stipulations were formulated nearly 30 years ago and were based on consultation with various Federal agencies and comments solicited from State, industry, environmental organizations, and academic representatives. These stipulations address conservation and protection of essential fish habitat/live-bottoms areas. The stipulations include exclusion of all oil and gas activity (structures, drilling, pipelines, production, etc.) on or near live-bottom areas (both high relief and low relief), mandatory shunting of drilling muds and cuttings near high-relief features, relocation of operations including pipelines away from essential fish habitat/live bottoms, and possible monitoring to assess the impact of the activity on the live bottoms. A continuous annual monitoring study has been ongoing at the East and West Flower Garden Banks since 1988.

Mitigating measures that are a standard part of the Bureau of Safety and Environmental Enforcement's OCS Program limit the size of explosive charges used for platform removal, require placing explosive charges at least 15 ft (5 m) below the mudline, establish No Activity and Modified Activity Zones around high-relief live bottoms, and require remote-sensing surveys to detect and avoid biologically sensitive areas such as low-relief live bottoms, pinnacles, and chemosynthetic communities.

In 2004, NTL 2004-G05, "Biologically Sensitive Areas of the Gulf of Mexico," was produced. This NTL combined the former topographic features stipulation guidelines, the live-bottom (pinnacle trend) stipulation, and the live-bottom (low-relief) stipulation. It also created a new class of features not previously identified in stipulations or NTL's—the potentially sensitive biological feature. This is defined as "not previously identified features of moderate to high relief that provide surface area for the growth of sessile invertebrates and attract large numbers of fish." This was an important new designation because these kinds of habitats are common outside named topographic features with their associated No Activity Zones and also outside of the 70 live-bottom (pinnacle trend) stipulated blocks. These kinds of habitats also played a major role in determining the boundaries of newly proposed HAPC's.

Subsequently, NTL 2009-G39 and NTL 2009-G40 have been produced. The NTL 2009-G39 changes the water depth applicability of NTL 2004-G05 from 400 m (1,312 ft) to 300 m (984 ft), makes minor changes to the list of affected OCS blocks, adds regulatory references, updates an NTL reference, makes minor administrative changes, and adds a guidance document statement. The NTL 2009-G40 broadens the scope of the previous NTL 2000-G20 to cover all high-density deepwater benthic communities (not just high-density chemosynthetic communities), changes the definition of deep water from 400 m (1,312 ft) to 300 m (984 ft), and increases the separation distance from muds and cuttings discharge locations from 457 m (1,500 ft) to 610 m (2,000 ft).

In consideration of existing mitigation measures, lease stipulations, and a submitted EFH assessment document, this Agency entered into a Programmatic Consultation agreement with NMFS on July 1, 1999, for petroleum development activities in the WPA and CPA. The NMFS considered an EFH assessment describing OCS development activities, an analysis of the potential effects, this Agency's views on those effects, and proposed mitigation measures as acceptable and meeting with the requirements of EFH regulations at 50 CFR Subpart K, 600.920(g). For the 1999 Programmatic Consultation, NMFS made the following additional recommendations (as numbered within the NMFS letter of agreement):

(5) When the Live Bottom (Pinnacle Trend) Stipulation is made a part of a pipeline laying permit, this Agency shall require that: No bottom-disturbing activities, including anchors from a pipeline laying barge, may be located within 30 m (100 ft) of any pinnacle trend feature with vertical relief greater than or equal to 2 m (8 ft).

(6) When the Topographic Features Stipulation is made a part of a permit that proposes to use a semi-submersible drilling platform, this Agency shall require that: No bottom-disturbing activities, including anchors or cables from a semisubmersible drilling platform, may occur within 152 m (500 ft) of the No Activity Zone boundary.

(7) When the Topographic Features Stipulation is made a part of a permit that proposes exploratory drilling operations, this Agency shall require that: Exploratory operations that drill more than two wells from the same surface (surface of the seafloor) location at any one or continuous time and within the 3-Mile Restricted Activity Zone must meet the same requirements as a development operation (i.e., drilling discharges must be shunted to within 10 m (33 ft) of the seafloor).

(8) When the Topographic Features Stipulation is required for any proposed permit around Stetson Bank, now a part of the Flower Gardens Banks National Marine Sanctuary (FGBNMS), the protective requirements of the East and West Flower Garden Banks shall be enforced.

(9) Where there is documented damage to EFH under the Live Bottom (Pinnacle Trend) or Topographic Features lease stipulation, this Agency shall coordinate with the NMFS Assistant Regional Administrator, Habitat Conservation Division, Southeast Region for advice. Based on the regulations at 30 CFR Subpart N, 550.200, “Remedies and Penalties,” BOEM’s Regional Director of the Gulf of Mexico OCS Region may direct the preparation of a case file in the event that a violation of a lease provision (including lease stipulations) causes serious, irreparable, or immediate harm or damage to life (including fish and other aquatic wildlife) or the marine environment. The conduct of such a case could lead to corrective or mitigative actions.

(10) The BOEM shall provide NMFS with yearly summaries describing the number and type of permits issued in the Gulf of Mexico WPA and CPA, and permits for activities located in the live bottom (pinnacle trend) and topographic features blocks for that year. Also, the summaries shall include a report of any mitigation actions taken by BOEM for that year in response to environmental damage to EFH.

This Agency has accepted and adopted these six additional EFH conservation recommendations. In fulfillment of Recommendation No. 10 above, this Agency has submitted reports to NMFS representing summaries of all annual activity related to topographic features lease blocks and live-bottom (pinnacle trend) blocks since the acceptance of the above Programmatic Consultation agreement.

Mitigating Factors

As discussed above, the Gulf of Mexico Fishery Management Council’s EFH preservation recommendations for oil and gas exploration and production activities are specified and are currently being followed by BOEM as mitigating actions to EFH. The BOEM regulations and lease sale stipulations already incorporate many of the suggested EFH conservation recommendations. In some cases, BOEM works with other Federal agencies to mitigate effects in an area. In addition, BOEM may attach mitigating measures as a condition of approval of an OCS plan or application (exploration, drilling, development, production, pipeline, etc.).

During the active lifetime of platforms, the subsurface portions of any structures in the WPA and CPA will act as reef material and a focus for many reef-associated species. The FMP’s specifically describe the use of artificial reefs as EFH. The South Atlantic Fishery Management Council (1998) also describes how manmade reefs are deployed to provide fisheries habitat in a location that provides measurable benefit to man. When manmade reefs are constructed, they provide new primary hard substrate similar in function to newly exposed hard bottom, with the additional benefit of substrate extending from the bottom to the surface. Reef structures of high profile seem to yield generally higher densities of managed and nonmanaged pelagic and demersal species than a more widespread, lower profile natural hard bottom or reef (South Atlantic Fishery Management Council, 1998). Wilson et al. (2003) reported fish densities as much as 1,000 times larger on platforms compared with surrounding mud bottom habitats and even equal to or greater than natural reef habitats such as the Flower Garden Banks. The benefits of artificial reefs created by the installation of energy-production platform structures are well documented in Gulf waters off the coast of Texas and Louisiana. More than 250 oil and gas platforms are also used as artificial reefs after they are decommissioned. See **Appendix A.4** for additional information on artificial reefs and the rigs-to-reefs development.

A new EFH consultation has been initiated between BOEM's Gulf of Mexico OCS Region and NMFS's Southeast Region. Some of the EFH requirements may change with the new agreement.

4.1.1.15.2. Impacts of Routine Events

Background/Introduction

Effects on fish resources and EFH from routine activities associated with a WPA 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 WPA are estuary dependent, coastal environmental degradation resulting from a WPA 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 4.1.1.4.2 and 4.1.1.5.2 consider effects from routine activities associated with a WPA 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, who will limit the levels of toxins from routine activities.

Routine activities associated with a WPA proposed action could impact topographic features (**Chapter 4.1.1.6.2**), deepwater benthic communities such as chemosynthetic and nonchemosynthetic (**Chapters 4.1.1.8.2 and 4.1.1.9.2**), soft-bottom communities (**Chapter 4.1.1.10.2**), 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 immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas maybe 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 **Chapter 2.3.1.3.1** 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 4.1.1.2.2.2**). Coastal operations could indirectly affect marine water quality through the migration of contaminated coastal waters (**Chapter 4.1.1.2.1.2**). *Sargassum* could be affected by changes to water quality due to routine activities (**Chapter 4.1.1.7.2**), but because of the ephemeral properties of the habitat and yearly life cycle of the algae, the effects are not estimated to hinder the population. Water quality is highly regulated and monitored by USEPA and USCG, so toxins should remain limited.

Proposed Action Analysis

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 WPA proposed action. Some resuspension of bottom contaminants will be realized during dredging operations, although little will be soluble in the water column and in bioavailable form. Many of these activities are regulated and mitigated through the COE and State permits, so coastal environmental degradation from a WPA 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, will regenerate quickly. At the expected level of effects on the coastal environment (EFH), the resultant influence on fish resources from a WPA proposed action would be negligible and indistinguishable from natural population variations (e.g., year-class abundance shifts from changes in climate of water circulations).

Marine Environmental Degradation

A WPA proposed action could potentially impact the marine environment through activities such as pipeline installation, structure emplacement and removal, and various discharges. For any activities associated with a WPA proposed action, USEPA's Region 6 would regulate discharge requirements for the WPA through their NPDES permits.

The projected length of pipeline installations for a WPA proposed action (a typical sale) is 237-554 km (147-344 mi) for all water depths (**Table 3-2**). 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 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 of a WPA proposed action on fish resources would be negligible and indistinguishable from other natural population variations.

The projected total number of production structure installations (15-23) resulting from a WPA proposed action is for all water depths (**Table 3-2**). Bottom disturbance from structure emplacement operations associated with a WPA proposed action would produce localized, temporary increases in suspended sediment loading 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 WPA. 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., 2001; 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 (16 ft) below the seafloor. It is projected that 11-19 structures in water depths <200 m (656 ft) in the WPA will be removed and that 7-13 of these will be removed using explosives as a result of a WPA proposed action (**Table 3-2**). 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 therefore not rise to any population-level impacts across the WPA or Gulf of Mexico generally.

The major sources of routine discharges to marine waters associated with a WPA 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 (9,842 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). Therefore, it appears that methylmercury concentrations near OCS activities are not significantly different from background levels in the Gulf of Mexico. 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). 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 WPA 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. Offshore topographic features are not expected to be impacted (**Chapter 4.1.1.6.2**).

Offshore discharges and subsequent changes to marine water quality are 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.

In addition, the Topographic Features Stipulation may be applied to a WPA proposed action. 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, which are a sensitive EFH, thereby increasing the distance between the features and their associated fish populations. For more information regarding stipulations for fish resources and EFH, see **Appendix D** and **Chapter 2.3.1.3.1**.

Summary and Conclusion

The BOEM has examined the analysis for impacts to fish resources and EFH based on the additional information presented above. Because of the mitigations described in the above analysis, a WPA proposed action is expected to result in a minimal decrease in fish resources and/or standing stocks or in EFH. It would require a short time for fish resources to recover from most of the impacts because impacts to the habitat would generally be temporary; fish tend to avoid areas of impact (thus reducing mortality effects) and most fish species are prolific reproducers. Recovery from the loss of wetlands habitat would probably not occur, but it would likely result in conversion of the lost wetland habitats into open water or mudflats, which may qualify as other forms of EFH.

It is expected that any possible coastal and marine environmental degradation from a WPA 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.

Additional hard-substrate habitat provided by structure installation in areas where natural hard bottom is rare would tend to increase fish populations. The removal of these structures would eliminate that habitat, except when decommissioned platforms are used as artificial reef material. This practice is expected to increase over time.

4.1.1.15.3. Impacts of Accidental Events

Background/Introduction

Accidental events associated with a WPA proposed action that could impact fish resources and EFH include blowouts and oil or chemical spills. The EFH that are covered throughout this document and that are affected by these possible accidents are water quality (**Chapters 4.1.1.2.1.3 and 4.1.1.2.2.3**), wetlands (**Chapter 4.1.1.4.3**), seagrass communities (**Chapter 4.1.1.5.3**), topographic features (**Chapter 4.1.1.6.3**), *Sargassum* (**Chapter 4.1.1.7.3**), chemosynthetic deepwater benthic communities (**Chapter 4.1.1.8.3**), nonchemosynthetic deepwater benthic communities (**Chapter 4.1.1.9.3**), and soft-bottom benthic communities (**Chapter 4.1.1.10.3**). These events and the effects to EFH are also summarized in **Appendix D**.

Blowout and Oil-Spill Impacts

Subsurface gas blowouts, although highly 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 feet or meters 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. 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. 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.

Oil loss from a blowout is possible; however, less than 10 percent of blowouts in recent history have resulted in spilled oil. 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. The loss of gas well control does not always release liquid hydrocarbons. The release of hydrocarbons with the gas is possible.

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 shellfish) 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 the death of eggs (NRC, 1985 and 2003). It can also result in the incorporation of hydrocarbons in organisms, causing tainting or accumulation in the food chain and changes in the biological habitat (Moore and Dwyer, 1974).

The level of impacts of oil on fish 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 and type of bacteria involved. Physical toxicity of oil to fishes, at least in part, 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. The effect of oil on fishes is also related to the distance from shore, the penetration into the estuaries, the location in the GOM, the time of the year that the spill occurs, and the amount of ichthyoplankton in the water. 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, official communication, 2010a), and none have been observed in Texas (Fisher, official communication, 2010b).

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 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 blue fin 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). The WPA does not contain any known spawning areas for the western Atlantic stock of bluefin tuna.

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. 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 6×10^{-5} ml/L to 125×10^{-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. suggest that the methane triggered a large methanotroph bloom that rapidly degraded the methane, leaving behind a residual methanotrophic community.

The effect of petroleum spills on fish resources as a result of a WPA proposed action is expected to cause a minimal decrease in most 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 WPA proposed lease sale area would be negligible and indistinguishable from natural population variations. 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).

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 highly migratory and would, based on typical observed behavior, actively avoid the spill area.

Proposed Action Analysis

At present, a WPA proposed action is estimated to result in the drilling of a total of 53-89 exploration wells and 77-121 development and production wells (**Table 3-2**). Of these production wells, 27-40 are estimated to be producing oil wells and 36-62 are estimated to be producing gas wells (**Table 3-2**). A blowout with hydrocarbon release has a low probability of occurring as a result of a WPA proposed action. A blowout with 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 1.3.1**. There is a 12-20 percent chance of one or more spills ≥1,000 bbl occurring with a WPA proposed action. 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 a spill is the smallest size group (<1 bbl). 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 WPA from a WPA proposed action after 10 days is <0.5-14 percent for the entire GOM; for specific State details, see **Figure 3-24**. The probability of an oil spill contacting an EFH in the WPA from a WPA proposed action after 30 days is <0.5-15 percent; for specific State details, see **Figure 3-24**. 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 WPA 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. 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 (**Chapter 3.2.1.7.1**). Therefore, the coastal waters of Louisiana, Texas, Mississippi, and Alabama will have a total of 200, 20, 30, and 10 spills <1,000 bbl/year, respectively, from all sources. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Texas, Mississippi, and Alabama will have a total of 130-170, 5-10, 3-5, and about 2 spills <1,000 bbl/year, respectively. Louisiana and Texas are the states most likely to have a spill ≥1,000 bbl occur in coastal waters. It is also assumed that a petroleum spill would occasionally contact and affect nearshore and coastal areas important to GOM fisheries. These species are highly migratory and 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 WPA 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. Fish and shellfish eggs and larvae would be unable to avoid spills and early development stages may be at greater risk. Fish populations may be impacted by an oil spill but they will be primarily affected if the oil reaches the shelf and estuarine areas because these are the most productive areas and because 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. The extent of the impacts of the oil would depend on the properties of the oil and the time of year of the event. Also, much of the coastal northern Gulf of Mexico is a moderate- to high-energy environment; therefore, sediment transport and tidal stirring should reduce the chances for oil persisting in these habitats if they are oiled.

The effect of WPA proposed-action-related oil spills on fish resources is expected to cause a minimal decrease in standing stocks of any population because the most common 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 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.

The BOEM has determined that it cannot obtain this information, regardless of cost, within the timeframe of 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 event on fish resources and EFH, the BOEM has determined that it is impossible for this Agency to obtain this information, regardless of cost, within the timeframe of this NEPA analysis, and it may be years before the information is available. This information is being developed through the NRDA process, data is still incoming and has 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 WPA 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.

4.1.1.15.4. Cumulative Impacts

Background/Introduction

This cumulative analysis summary includes effects on fish resources and EFH's of the OCS Program (a WPA 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, such as 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 4.1.1.4.4**). Marine environmental degradation factors affecting water quality, such as hypoxia, are discussed in **Chapters 4.1.1.2.1.4 and 4.1.1.2.2.4**. Physical disturbances of topographic 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 **Chapter 4.1.1.6.4** 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, a large portion of the GOM is designated as EFH. The effects of cumulative actions on offshore water quality, topographic features, *Sargassum*, chemosynthetic and nonchemosynthetic communities, and soft-bottom communities are analyzed in detail in **Chapters 4.1.1.2.2.4, 4.1.1.6.4, 4.1.1.7.4, 4.1.1.8.4**, **4.1.1.9.4**, **and 4.1.1.10.4**, 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 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 WPA 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 WPA. 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 5,224-12,339 km (3,246-7,667 mi) of pipeline is projected to be installed in the WPA (in water depths of <60 m; 200 ft) during the 40-year analysis period (**Table 3-5)**.

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 WPA consist of the East and West Flower Garden Banks and Sonnier and Stetson Banks. The Topographic Features Stipulation, 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 is done by focusing OCS activities at specified distances from the topographic 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. Also, the guidelines provided in NTL 2009-G40 would decrease 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 WPA during the next 40 years and for all water depths is 255-384 (**Table 3-5**). Bottom disturbance from structure emplacement operations associated with a WPA 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 WPA. Structure removals would result in artificial habitat loss. It is estimated that 233-350 structures would be removed as a result of the OCS Program in the WPA during the next 40 years (**Table 3-5**). The removal of structures by using explosives results in the loss of artificial habitat and causes fish kills. It is estimated that 160-240 structures would be removed using explosives as a result of the OCS Program in the in the WPA over the next 40 years (**Table 3-5**). 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 would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2001). The Topographic Features Stipulation, 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. Also, the guidelines provided in NTL 2009-G40 would decrease impacts on other deepwater benthic communities such as chemosynthetic, nonchemosynthetic, and soft bottoms. This includes bottom-disturbing activities such as anchoring and structure emplacement and removal.

Localized, minor degradation of coastal water quality is expected from a WPA 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 4.1.1.2.1.4**). Because the input of effluent, runoff, and nutrients from a WPA 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 WPA proposed action would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes and sedimentation/sediment resuspension (**Chapter 4.1.1.2.2.4**). 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 (3,280 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 (Treffry 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 (3,280 ft) of the discharge point, and would have a negligible effect on fish resources. The use of BOEM's stipulations would buffer different 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 WPA 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 would, 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 (65 ft; mostly sublethal impacts). A comprehensive survey of all low-relief live bottoms in the WPA has yet to be conducted, but all major topographic features are well described (**Chapter 4.1.1.6.1**). Only three high-relief features in the Gulf rise to water depths shallower than 20 m (65 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).

Subsurface spills (pipeline spills) could cause localized, sublethal (short-term, physiological changes) impacts on the biologically sensitive underwater features and areas and deepwater benthic communities; 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 <1 spill ≥1,000 bbl would occur as a result of a WPA proposed action (**Table 3-12**). A large coastal spill that could occur from OCS-related activity in the WPA would likely originate near terminal locations in the coastal zone of Texas, primarily within the Houston/Galveston area. 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. For oil spills ≥1,000 bbl, if a spill was to occur due to a WPA proposed action, the probability of that spill contacting an EFH after 10 days is <0.5-14 percent. If a spill was to occur, the probability of that spill (≥ 1,000 bbl) contacting an EFH after 30 days is <0.5-15 percent.

Subsurface gas blowouts of both oil and natural gas wells have the potential to affect adversely fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf of Mexico OCS. Considering the entire Western Planning Area OCS Program during the 40-year analysis period, it is estimated that there would be less than one platform spill of ≥1,000 bbl from the estimated 2,630-3,710 development wells (<1%) for all water depths in the WPA (Ji et al., in preparation). 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 WPA 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 in Texas 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 WPA are also causing the expansion of ports and marinas there. Where new channels are dredged, wetlands would be adversely impacted by the channel, the 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 Texas 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. 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. 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 the levels of contaminants in some fish, thereby 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. In 2009, the 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 4.1.1.16.1 and 4.1.1.17.1** 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 by changing physical characteristics of inshore and offshore ecosystems. The incremental contribution of impacts on fish and EFH from a WPA proposed action to the cumulative impacts on offshore communities would be small (as analyzed in **Chapters 4.1.1.6.4, 4.1.1.7.4, 4.1.1.8.4, 4.1.1.9.4, and 4.1.1.10.4**).

Summary and Conclusion

In summary, along with a WPA 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 WPA proposed action, sediment would potentially be resuspended in the 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. 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 OCS effects to finfish 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 WPA coast are also causing the expansion of ports and marinas there. The coastal waters of Texas 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 contributed in a large way to 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 Gulf of Mexico Fisheries Management Council. 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 as 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 WPA proposed action, are now monitored, regulated, and mitigated by the permitting agency or State. These efforts will continue in the future, and the restoration of habitats could increase with better technologies. While EFH and fish resources are impacted by these many factors, a WPA proposed action would add a minimal amount to the overall cumulative effects.

As noted above (in **Chapter 4.1.1.15.1**, affected environment), most of the Gulf of Mexico is designated as EFH and encompasses many different types of habitats and resources, which are 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 is still incoming and has 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 it 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 WPA 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.

4.1.1.16. Commercial Fishing

The full analyses of the potential impacts of routine activities and accidental events associated with a WPA 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 WPA, such as seismic surveys and pipeline trenching, would cause negligible impacts and will not deleteriously affect commercial fishing activities. Indirect impacts from routine activities to inshore habitats are negligible and indistinguishable from direct impacts of inshore activities on commercial fisheries. The potential impacts from accidental events (i.e., a well blowout or an oil spill) associated with a WPA 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. The incremental contribution of a WPA 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.

4.1.1.16.1. 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. Changes can occur on short notice, especially time closures based on allowable catches. The Gulf of Mexico Fishery Management Council (GMFMC) provides the current information on commercial and recreational fishing rules for U.S. Federal waters of the Gulf of Mexico (GMFMC, 2011).

The Gulf of Mexico provided 33 percent 34 percent, and 30 percent of the number of pounds of seafood landed in the United States (with the exception of Alaska) in the years 2008, 2009 and 2010, respectively. This amounted to approximately 22 percent, 24 percent, and 23 percent of the value of the total catch for each of these respective years in the United States, again excluding Alaska (USDOC, NMFS, 2011f).

Menhaden, with fisheries 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, 2011f). In 2010, the Gulf menhaden harvest was approximately 0.97 million pounds worth $66 million. The catch was down approximately 30 percent from 2009, but it was up approximately 4 percent from the 2008 harvest.

In the WPA, for the years 2008 and 2009, the two most important finfish species landed have been, in order of pounds landed, black drum and red snapper. In 2008, the catch of black drum was nearly 1.5 million pounds worth nearly $1.4 million. In 2009, the black drum catch was 1.6 million pounds worth nearly $1.4 million and in 2010, the black drum catch was 1.7 million pounds worth $1.6 million. Red snapper landings in Texas declined from 1.2 million pounds worth $3.7 million in 2008 to 850,000 pounds in 2009 worth $2.4 million, and the catch increased in 2010 to 1.0 million pounds worth $2.9 million (USDOC, NMFS, 2011f)..

Shrimp (brown, pink, royal red, and white), with landings of over 256.5 million pounds and valued at about $314 million, were the most important shellfish, in terms of value, landed during 2009. Shrimp production was up throughout the Gulf from 186.3 million pounds in 2008 to 226.5 million pounds in 2009, although the value of the catch was down from $356.3 million in 2008 to $208 million in 2009. The catch in 2010 was down to approximately 175 million pounds, probably as a result of widespread closures in the shrimping grounds of Louisiana, Mississippi, and Alabama. The catch value in 2010 was approximately $330 million. Blue crabs, another of the most valued shellfish of the Gulf Coast, produced 59.1 million pounds in 2009 worth approximately $43.7 million (USDOC, NMFS, 2011f). The blue crab harvest in the Gulf Coast States decreased to 41.0 million pounds in 2010 (30.4%) worth $41.0 million (USDOC, NMFS, 2011f).

Texas produced 37.5 million pounds of brown shrimp worth $85.7 million and 25.2 million pounds of white shrimp worth $67.9 million in 2008. In 2009, brown shrimp production in Texas was up to 65.2 million pounds worth $86.8 million, and in 2010, the brown shrimp harvest declined to 48.3 million pounds, but the catch value was up to $99 million. White shrimp production in 2009 was down slightly to 23.4 million pounds worth $40.8 million, but it rebounded in 2010 to 27.3 million pounds with a catch value of $70.9 million. Blue crab production inTexas was 2.6 million pounds worth $2.3 million in 2008, and it was up slightly in 2009 to 2.8 million pounds worth $2.5 million. Texas blue crab catch climbed in 2010 to 3.3 million pounds worth approximatey $3.1 million (USDOC, NMFS, 2011f).

The American oyster (*Crassostrea virginica*) is also harvested in Texas estuaries from Galveston Bay west to East Matagorda Bay. Historically, the largest oyster harvest in Texas comes from Galveston Bay because of its favorable salinity regime. In 2008, the total harvest of oyster meats from Texas was 2.7 million pounds worth approximately $8.8 million dollars. This is down from 5.6 million pounds worth approximately $19.3 million in 2007, a 110 percent decrease in harvest. Oyster harvest in Galveston Bay was down 0.7 million pounds (-38%) in 2008, and the oyster harvest in San Antonio Bay was down 1.1 million pounds of meats (-1,408%). Harvest of oyster meats decreased in all bays across the coast with the exception of East Matagorda Bay where the harvest, although small (9,700 pounds), was up 71 percent in 2008 over the 2007 harvest of 2,800 pounds (Fisher, official communication, 2010b). Most of the decrease can be attributed to Hurricane Ike. The 2009 harvest was again approximately 2.7 million pounds, indicating that either the beds and/or the infrastructure have not recovered from the effects of Hurricane Ike (USDOC, NMFS, 2011f). The 2010 Texas oyster harvest was up to 5.2 million pounds, reflecting an increased demand and a possible recovery or at least a partial recovery of Galveston Bay oyster beds and infrastructure from Hurricane Ike (USDOC, NMFS, 2011f).

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. Hurricane damage sustained by the fisheries in Galveston Bay as a result of Hurricane Ike, with emphasis on the oyster infrastructure, is documented by Haby et al. (2009). This report estimates losses in excess of $31 million, including private leases, docks, fuel systems, plants, and inventories in the oyster industry alone, although docks and fuel systems often serve multiple commercial as well as recreational fisheries.

Large amounts of silt were deposited on oyster beds in Galveston Bay by Hurricane Ike. The Texas Parks and Wildlife Department currently has two oyster reef restoration projects underway in Galveston Bay. The larger of these projects involves planting 20 ac (8 ha) of cultch in East Bay, an area heavily silted by Hurricane Ike, to rebuild reef commercial reef (Texas Parks and Wildlife Department, 2009).

The DWH event, which affected much of the Gulf of Mexico, was largely to the east of Texas. There were no fishery (recreational or commercial) closures in Texas, no oyster bed closures, and only a single report of oil on Galveston Island (Fisher, official communication, 2011b). The potential oiling footprint as reported through 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.

Stock Status

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 2009 status report (USDOC, NMFS, 2010c), they reviewed 522 individual stocks and stock complexes, and made determinations of overfishing and overfished for 193 complexes; an additional 67 stocks have either an overfishing or overfished determination. Overfishing is harvesting at a rate above a prescribed fishing mortality threshold, and overfished is defined as a stock size that is below a prescribed biomass threshold. Overfished species in the Gulf of Mexico are red snapper, greater amberjack, gag grouper, and gray triggerfish. Each of these species is discussed in **Chapters 4.1.16.1 and 4.1.1.17.1**. All of these species occur throughout the GOM in and around reefs. The effects of the DWH event on each of these species are unknown at this time. For the WPA, the Bureau of Ocean Energy Management anticipates that impacts to these species, on a population level, would be minor, given that the lateral extent of the plume and sheen remained east of the WPA boundary and that there were no fishery closures within the WPA. For this reason, incomplete or unavailable information on the effects of DWH event on these stocks would not be expected to be relevant to reasonably foreseeable significant adverse impacts at the population level.

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 $629 million in 2009. Texas had around $150 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, 2010d). 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 depend 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 Gulf of Mexico. Texas has approximately 18,874 jobs in the industry. 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.

Although the DWH event impacted commercial fishing in the Gulf of Mexico, few impacts were apparent in the WPA. The majority of the impacts of the spill on commercial fisheries were felt in the CPA region and in Florida during the ongoing spill, and these impacts were primarily the result of fisheries closures. There were no closures in the WPA.

Although the DWH event impacted commercial fishing in the Gulf of Mexico as a whole, few if any impacts occurred in the WPA. This is based on the fact that the lateral extent of the spill and sheen associated with the DWH event remained east of the WPA boundary and that there were no fishing closures in the WPA because of the DWH event and spill. The majority of the impacts of the spill on commercial fisheries were felt in the CPA region and in Florida.

4.1.1.16.2. Impacts of Routine Events

Background/Introduction

Healthy fishery stocks depend on EFH 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 **Chapter 4.1.1.15.1**) for species in the WPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the EEZ. Since the majority of the commercial species harvested within the WPA are estuary dependent, coastal environmental degradation resulting from a WPA proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries in the WPA may be affected by activities resulting from a WPA proposed action (**Chapter 4.1.1.4.2**). These activities include construction of new onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channel and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum field wastes, and spills from both coastal and offshore OCS-support activities. Most of the wetlands loss in the WPA, however, is a result of residential and industrial development in wetlands.

Coastal water quality (**Chapters 4.1.1.2.1.1 and 4.1.1.2.1.2**) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters, may impact water quality conditions. Since many of the fish species harvested within the WPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a WPA proposed action, although indirect, has the potential to adversely affect EFH and fish resources.

Offshore EFH includes both high-relief and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Three banks in the WPA are of particular importance. Stetson Bank and the East and West Flower Garden Banks now comprise the Flower Garden Banks National Marine Sanctuary, and they are also considered EFH habitat areas of particular concern.

Activities resulting from a WPA proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include 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. The Topographic Features Stipulation (**Chapter 2.3.1.3.1**) would prevent most of the potential impacts from a WPA proposed action on topographic features communities/EFH from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Direct effects on commercial fishing from routine offshore activities could result from the installation of production platforms, 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 for the life of the project, which could be over 20 years. Underwater OCS obstructions such as pipelines can cause loss of trawls and catch, as well as fishing downtime and vessel damage.

Production platform decommissioning and removal activities in water depths <200 ft (61 m) remove artificial reef habitat and often involve 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. 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 would not be expected to rise to population-level impacts.

Intense sounds generated by seismic surveys affect the spatial distribution of fish during and for some period following exposure. 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 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 mi).

The most commonly discharged offshore wastes are drilling mud and produced water. Drilling mud contains metals such as mercury and cadmium, which are toxic to fishery resources; however, the 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 less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds.

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, Trefry et al. (2003) found that methylmercury concentrations did not vary significantly between near-field and far-field sites. Further, the study suggested that levels of methylmercury in sediments around drilling sites are not a widespread phenomenon in the Gulf of Mexico (Trefry et al., 2003). 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. 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, 1997a). Produced water has not been shown to cause fish mortality in populations surrounding platforms. Produced water dilutes rapidly after discharge and 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 offshore 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.

Proposed Action Analysis

The routine activities associated with a WPA 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.

Wakes from vessel traffic erode natural and manmade inland waterway banks, exacerbating coastal erosion in wetlands and therefore creating a conduit for the increased intrusion of salt water. This intrusion of saltwater, as it progresses inland, destroys intermediate and fresh marsh grasses and creates open-water areas downstream. Traffic from offshore facilities, however, contributes a minor portion of the total inshore vessel traffic. It is, therefore, considered to be a minor contribution to the loss of wetlands, especially as compared with commercial and residential development in wetlands.

Marine trash and debris has been recognized by USEPA (1992) as a problem in the Gulf of Mexico. While several laws regulate litter and debris at sea, legislation does not guarantee compliance. A listing of the applicable laws includes the Federal Water Pollution Act Amendments of 1972; Coastal Zone Management Act; Marine Protection, Research and Sanctuaries Act; International Convention for the Prevention of Pollution from Ships; Act to Prevent Pollution from Ships; Marine Plastic Pollution Research and Control Act; Shore Protection Act; Beaches Environmental Assessment and Coastal Health Act; Coral Reef Conservation Act; and Marine Research Prevention and Reduction Act. In addition, this Agency has issued NTL 2002-G-13 advising offshore operators to provide training in waste disposal to all personnel employed on offshore facilities and to provide certification of this training to BSEE on a yearly basis. Based on the education of offshore personnel, it is anticipated that the disposal of marine trash has been minimized.

The number of production structures projected as a result of a WPA proposed action ranges from 15 to 23. Applying a 500-m (1,640-ft) safety zone around a platform would exclude approximately 193 ac (78 ha) from commercial fishing per structure, assuming that the operator applied to USCG for a safety zone around the platform. The total number of platforms projected in the WPA in water depths <200 m (656 ft), the area in which concentrated bottom trawling occurs, is 11-18. 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 WPA in water depths <60 m (200 ft) is from 44 to 133 km (27 to 70 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 would not conflict with commercial fishing in deeper waters. Pipeline trenching does produce localized turbidity that can cause clogging of gills, and the displaced sediment can result in smothering benthic communities in close proximity to the activity. Because fish actively avoid the turbidity plume, the effects of pipeline trenching are not expected to be significant in the WPA. The area of benthic community smothered in this activity is small and it is not expected to cause a significant impact to the overall benthos of the coastal 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 14-22 removals would occur in the WPA in water depths <200 m (656 ft) as a result of a WPA proposed action. 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.

Seismic surveys would occur in both shallow and deep waters of the WPA. Seismic survey vessels are of temporary presence in any commercially fished area of the WPA. 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 the overall WPA 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 drilling mud are discharged in shallow and deep waters of the WPA. Studies of drilling 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 drilling 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.

Summary and Conclusion

Some of the impact-causing actions described above are mitigated by BOEM through the Topographic Feature Stipulations applied to each lease sale that establishes a No Activity Zone around important topographic features, such as the Flower Garden Banks. Also, NTL 2009-39 advises operators to avoid hard-bottom habitats that support fish populations, and USEPA's discharge permit system mitigates potential impacts from produced water.

Much of coastal wetland loss that supports the estuaries upon which fish stocks are dependent is 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 is in a limited area by the produced-water discharge and the overboard discharge of drilling muds. Pipeline trenching, maintenance dredging, and canal widening in inshore areas causes only temporary suspension of sediments. Negative impacts from most of these routine operations would require a short time for fish resources to recover. Recovery from the loss of wetlands habitat would probably not occur.

Space-use conflicts will continue in the offshore area, although the area off limits to fishing (especially longlining) is small. Some gear loss will continue to occur as will down time from seismic surveys. The Fishermen's Compensation Fund compensates U.S. commercial fishermen and other eligible citizens and entities for property and economic loss caused by obstructions related to oil and gas development activities on the OCS. The NMFS administers and processes Fishermen's Contingency Fund claims, and BOEM coordinates communications with OCS leaseholders and maintains the database for reported obstructions. The level of impact of a WPA proposed action on the commercial fisheries in the WPA is expected to be small.

Additional hard-substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase 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.

Negative impacts from most of these routine operations would require a short time for fish resources to recover. Recovery from the loss of wetlands habitat would probably not occur.

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 WPA proposed action is expected to result in a minimal decrease in fish resources.

4.1.1.16.3. 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 shore-based spills would be very small, limited to the storage capacity, and would require shorter response time. 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 risk of oil-spill events, both inshore and offshore, are discussed in **Chapter 3.2.1**.

Blowouts

Subsurface blowouts have the potential to adversely affect fish resources and commercial fishing. A blowout at the seafloor could create a crater, and resuspend and disperse large quantities of bottom sediments within a 300-m (984-ft) radius from the blowout site, potentially affecting a limited number of fish in the immediate area. A blowout event in deep water, although highly unlikely, could cause damage to the nearby bottom and render the affected area closed to bottom fisheries, such as bottom longlining for tilefish or grouper, or deep-sea trawling for royal red shrimp for some period of time. The majority of mobile fish taxa would be expected to leave the area. A blowout in shallow water would potentially disperse large quantities of sediment, causing mobile species to leave the area and result in fisheries closure for trawling and/or recreational fishing. Resuspended sediments may clog gill epithelia of both finfish and shellfish with resultant smothering. The settlement of resuspended sediments may directly smother invertebrates or cover burrows of commercially important shellfish.

Oil Spills

The risk of oil spills from a WPA proposed action, their characteristics, sizes, frequency, and fate are discussed in **Chapter 3.2.1**. Spills that may occur as a result of a WPA proposed action have the potential to affect fish resources, EFH, and commercial fishing in the Gulf. The toxicity of an oil spill depends on the concentration of the hydrocarbon components exposed to the organisms (in this case fish or "shellfish"), the amount of oil released, the geographic area covered by the oil, 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 water temperature. The toxicity of any oil to any particular species is also a function of the sensitivity of the species considered.

The geographic range of the spill effect depends on the volume and duration of the spill, the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question. Adult fish tend to avoid contact with oil in the water column. 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), incorporations of hydrocarbons in organisms causing tainting or accumulation in the food chain, and changes in biological habitat. Intertidal and subtidal habitats may be of the most concern in that organisms inhabiting these environments may be excluded from oiled areas (Moore and Dwyer, 1974).

Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). Upon exposure to spilled petroleum, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Environmental stresses may increase the sensitivity of fish to petroleum toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985). When contacted by spilled hydrocarbon, floating eggs and larvae, with their limited mobility and physiology, and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977; McGurk and Brown, 1996). Large numbers of fish eggs and larvae have been killed by oil spills. Probably the most well-known case of this is the documented mortality of pacific herring after the *Exxon Valdez* oil spill. Carls et al. (1998) documented the malformations, genetic damage, and mortality of Pacific herring eggs when exposed to Alaskan crude in concentrations as low as 0.7 ppb PAH's with sublethal effects, such as premature hatching occurring in concentrations as low as 4 ppb.

Sublethal effects on larvae, including genotoxic damage, have also been documented from sites oiled from the *Exxon Valdez* (DeMarty et al., 1997). Hose et al (1996) also detected genetic damage in Pacific herring from sites within the oil trajectory of the *Exxon Valdez* spill 2 months after the spill, with decreasing rates of genotoxicity for an additional 2 months after the spill. No genotoxicity was detectable from sampling conducted two years following the spill.

Fish overproduce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. Even a heavy death toll of eggs and larvae from an oil spill may have no detectable effect on the adult populations exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of both fish eggs and larvae of pilchard and pollack, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991). Adult fish are likely to actively avoid a spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982; Maki et al., 1995). Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (Lancaster et al., 1998; Squire, 1992). Fish swim away from spilled oil, and this behavior explains why there has never been a commercially important fish kill on record following an oil spill. Delayed effects on growth and marine survival of pink salmon have been reported after exposure to crude oil during embryonic development (Heintz et al., 2000).

The only substantial adult fish kill on record following an oil spill was on the French coast when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck. In addition, some concerns about the impact of spilled oil on the breeding cycle of commercial fishery resources have proved to be unfounded (Baker et al., 1991). Some work has reported potential sublethal impacts, including the expression of subclinical viral infection correlated to experimental exposure of adult Pacific herring exposed to weathered crude oil (Carls et al., 1998). Spills that contact coastal bays, estuaries, and waters of the OCS, when pelagic eggs and larvae are present, have the greatest potential to affect commercial fishery resources. For eggs and larvae contacted by a spill, the effect is expected to be lethal. Migratory species such as mackerel and cobia could be impacted if a spill contacts nearshore open waters.

A spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs. Most of the commercial fish and shellfish harvested in the WPA are estuarine dependent at some point in their life cycles. These fish and shellfish include brown shrimp, white shrimp, pink shrimp, blue crabs, Atlantic 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. Chronic petroleum contamination in an inshore area would affect all life stages of a localized population of a sessile fishery resource such as oysters. Nonmotile shellfish (e.g., oysters) would not be able to avoid a spill but could shut down filtering for some period of time, depending on the water temperature and other environmental conditions. For OCS-related spills to have an effect on an offshore commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be abnormally concentrated in the immediate spill area (Pearson et al., 1995). Hydrocarbon components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977).

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 closures 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. Long-term or large area closures may also have negative economic impacts on fishermen and fishing communities. 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. The NRDA action will spearhead these efforts, but it has not published relevant data. Regardless of the costs of acquiring these data, given the realities of the NRDA process, these data will not be available within the timeframe contemplated for this NEPA analysis. In any event, this information is not essential to a reasoned choice among the alternatives because catastrophic events remain extremely low-probability events (**Appendix B**).

Blowout and Oil-Spill Impacts

A blowout with hydrocarbon release has a low probability of occurring as a result of a WPA proposed action. A blowout with oil release is not probable to occur, but it is possible given the occurrence of the DWH event. Since the DWH event, however, BOEM has implemented a number of regulation changes to reduce the possibility and severity of another such event. These regulations are described in detail in **Chapter 1.3.1**.

An offshore 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, will 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. The methanotrophs are bacteria that are able to metabolize methane as their only source of carbon and energy. Their populations therefore increase when methane is released into the system, and they are able to oxidize the available methane. Any impacts are expected to have been temporary, and in general, fish, including commercial stocks, typically avoid areas of low dissolved oxygen.

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, has the potential to affect finfish through direct ingestion of hydrocarbons or ingestion of contaminated prey. 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 will be at a maximum during the spawning season of any commercially important population, exposing larvae and juveniles 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 will 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 EEZ, 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 increase population levels during the period of closure. Closure to harvest may also have negative economic impacts on fishermen and fishing communities depending on the size of the closed area and the length of closure.

Recent data collected by Dauphin Island Sea Lab researchers from stations outside of the barrier islands and in 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 were most abundant in the estuaries (as compared with outer stations) both pre- and post-spill. (Valentine, official communication, 2010). Area closures may, therefore, have a somewhat positive impact on certain inshore commercial fisheries populations, even in the context of an accidental event.

Summary and Conclusions

The BOEM has examined the available data for impacts of a WPA proposed action to commercial fisheries in the WPA. Accidental events that could impact commercial fisheries 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 fisheries resources in the immediate area of the blowout.

Oil spills on the OCS due to a WPA proposed action are highly unlikely. If oil spills due to a WPA 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 avoid a spill. This behavioral mechanism allows them to move away from the source of the hydrocarbons, therefore minimizing the likelihood of fish kills.

The most damaging oil spills to commercial fisheries populations would be those reaching the productive shelf or estuaries. Negative impacts would be maximum on those populations that are short lived and harvested annually, such as crabs and shrimp, or those populations that are sessile, such as oysters. Spills of this magnitude from the EEZ have, however, a very low probability of occurrence historically.

Most closures from oil spills are small and short lived. Fishermen are generally able to avoid the area, causing only localized economic impacts. Large-scale closures are rare but can temporarily inflict a negative impact on commercial fishermen and the sale of local fish products. Closures may also relieve fishing pressure and allow fisheries populations to increase the following year.

In summary, the impacts of a WPA proposed action from accidental events (i.e., a well blowout or an oil spill) are anticipated to be minimal 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.

4.1.1.16.4. Cumulative Impacts

Background/Introduction

This cumulative analysis considers activities that have occurred, are currently occurring, and could occur and adversely affect commercial fishing for the years 2012-2051. These activities include the effects of the OCS Program (proposed action and prior and future OCS sales), State oil and gas activity, the status of commercial fishery stocks, oil transport by tankers, natural phenomena, and commercial and recreational fishing.

Specific types of impact-producing factors considered in the cumulative analysis include the following: (1) commercial fishing techniques or practices; (2) hurricanes; (3) installation of production platforms and underwater OCS obstructions; (4) production platform removals; (5) seismic surveys;

(6) petroleum spills; (7) subsurface blowouts; (8) pipeline trenching; and (9) 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. The effects of overfishing of finfish resources are discussed in **Chapter 4.1.1.16.1**. The competition for the resource, 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. Bycatch of the commercial shrimping industry is also a significant factor in the population decline of the red snapper.

Space-use conflicts and conflicts over possession of the resources can result from different forms of commercial operations and can occur between commercial and recreational fisheries. These effects have resulted in State and Federal constraints such as weekday fishing only, quotas, and/or gear restrictions on commercial fishing activity. Also, hurricanes could impact commercial fishing practices by damaging the gear, displacing the resource, and changing the availability of supplies.

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 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 WPA proposed action is expected to be minor.

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), therefore affecting commercial fishing. Hurricanes suspend fishing activity and are destructive to wetlands that are 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 to commercial fisheries from the hurricanes 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 WPA proposed action is anticipated to result in the installation of 15-23 new production facilities (**Table 3-2**). These production 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 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 WPA for fishing. Because the footprint area of OCS structures is small and easily avoided by fishing vessels, the impact of a WPA proposed action on commercial fisheries is anticipated to be small.

Platform Removals

Offsetting the anticipated installation of platforms in the WPA is the anticipated removal of 14-22 existing platforms (**Table 3-2**). 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, 7-13 platforms are anticipated to be removed using explosives (**Table 3-2**). Explosives cause mortality in fish with swim bladders when they are either associated with the platform or are 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 for a short period of time 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 WPA proposed action are discussed in detail in **Chapter 3.2.1**. Large spills can affect commercial fisheries resources by causing potential losses to commercial fish populations. These potential population losses may be offset by commercial fisheries closure areas necessitated by a large spill. 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 size of non-OCS-related spills in the WPA is expected to be small 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 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. 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 because of the infrequency of the event and the small spatial scale of the disturbance relative to the size of the Gulf of Mexico. 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 WPA proposed action.

Pipeline Trenching

Pipeline trenching also has the potential to affect commercial fisheries as a result of sediment suspension. Sandy sediments are quickly redeposited within 400 m (1,312 ft) of a 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 pipeline trenching because these are temporary events at localized areas. 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 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.

One of the main concerns of the concentrations of metals in the drilling muds is that mercury can be magnified in the food chain. Numerous studies, however, have concluded that platforms do not contribute to higher mercury levels in marine organisms. Recent data furthermore suggest that mercury in sediments near drilling platforms is not in a bioavailable form (Trefry and Smith, 2003).

Offshore discharges of drilling mud have been shown to dilute to near background levels within 1,000 m (3,281 ft) of the discharge point and would not cause a concentration of mercury in the food chain. These discharges would therefore have a negligible cumulative effect on fisheries because of the dilution of the metal to background levels before it enters the food chain. Produced-water discharges contain components and properties detrimental to commercial fishery resources. Offshore discharges of produced water also disperse and dilute to near background levels within 1,000 m (3,281 ft) of the discharge point and have a negligible cumulative effect on fisheries. Discharges due to OCS activities are discussed in **Chapter 3.1.2.2**. No mortality has been attributed to produced-water discharges, and no consensus of sublethal effects to fish has been reported in the literature (**Chapter 4.1.1.16.2**). Offshore discharges and subsequent changes to marine water quality are closely regulated by the U.S. Environmental Protection Agency's NPDES permits.

Methylmercury is the bioavailable form of mercury. Biomagnification in large fish of higher trophic levels is a problem in the Gulf of Mexico. The bioavailability and any association with trace concentrations of mercury in discharged drilling mud have 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. Sampling results of methylmercury in the vicinity of OCS structures does not vary significantly from background concentrations.

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.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events have the potential to cause limited detrimental effects to commercial fishing, landings and the value of those landings. The impact-producing factors of the cumulative scenario that are expected to substantially affect commercial fishing include commercial and fishing techniques or practices (overfishing), hurricanes, installation of production platforms and underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling mud and produced waters.

Because the area of the installation of production platforms is small as compared with the area available in the WPA for fishing and because the impacts from platform removals are so localized, the cumulative impact of these activities with a WPA proposed action to the commercial fisheries is anticipated to be minor. The effects of seismic surveys have been determined to be limited in time and space. The effects of seismic surveys are, therefore, expected to be minimal overall.

Subsurface blowouts, such as the DWH event, that include both oil and natural gas have the potential to affect fish populations, particularly eggs and larvae. The full effects of this type of spill on individual fisheries in the Gulf of Mexico are currently unknown, but spills of this type are a low-probability event. The potential impacts are discussed in **Appendix B**. Because spills of this magnitude are low-probability events, their contribution to the cumulative impact on commercial fisheries populations is not expected to be large as a result of a WPA proposed action.

Significant contributions to cumulative impacts from oil and gas activities are not anticipated as a result of pipeline trenching because sandy sediments are quickly redeposited within 400 m (1,312 ft) of a trench, and finer sediments are widely dispersed and redeposited over a period of hours to days within a few thousand meters of the event. These are small areas as compared with the rest of the Gulf of Mexico, and they are temporary disturbances.

Offshore discharges of drilling mud have been shown to dilute to near background levels within 1,000 m (3,281 ft) of the discharge point. Because offshore discharges of produced water disperse and dilute to near background levels within 1,000 m (3,281 ft) of the discharge point and because of mercury in sediments near drilling platforms is not in a bioavailable form, the contribution of produced-water discharges to the cumulative impacts of a WPA proposed action is not anticipated to be significant.

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 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 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 contributed in a large way to the decline of some populations of Gulf of Mexico of commercial fish species. 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. The 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 of pollution 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 USEPA or State agencies.

Oil spills or gas well blowouts, although considered a rare event, can affect offshore waters. 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 to the explosion at the time of removal. 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 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 that vary in numbers from year to year 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, as well as possibly overfishing and bycatch.

4.1.1.17. Recreational Fishing

A WPA 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 significantly impact recreational fishing activity due to the short-term duration of their impacts and due to 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 WPA proposed action should not have large effects on recreational fishing activity since it does not significantly increase the likelihood of an additional spill along the lines of the DWH event.

4.1.1.17.1. Description of the Affected Environment

A WPA 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 coast of Texas since this is the area most directly affected by a WPA proposed action sale; the baseline environment for recreational fishing in Louisiana, Mississippi, Alabama, and Florida is presented in **Chapter 4.2.1.20.1**. Data on effort and catch levels for the most often fished species are first discussed. This is followed by a description of the interaction between recreational fishing activity and the broader economy of the region. The final section presents some initial evidence regarding the impacts of the DWH event on recreational fishing activity in Texas.

Catch and Effort Data

Recreational fishing data for Texas is collected by the Texas Parks and Wildlife Department (2011a). The NMFS, which provides recreational fishing data for most other states in the United States, does not report data for Texas. Panel A of **Table 4-18** presents data on the most commonly landed species in Texas waters in 2007, 2008, 2009, and 2010. Spotted seatrout accounted for the largest number of landings in all years; there were approximately 732,000 landings in 2010. Red drum was the second most landed species, followed by black drum, sand seatrout, and Atlantic croaker. Catch rates for most species have not exhibited a strongly upward or downward trend in recent years; however, landings of black drum have increased steadily over the past 4 years, while landings of spotted seatrout have gradually decreased since 2008

Panels B, C, and D of **Table 4-18** present data on fishing in inshore bays, State waters, and the EEZ of the Texas coast. The vast majority of fishing activity in Texas occurs in the extensive bay systems along the coast of Texas. This is particularly true for spotted seatrout, red drum, black drum, Atlantic croaker, and sand seatrout. Data on catch rates of particular species for Texas bays can be accessed on the Texas Parks and Wildlife Department's website (Texas Parks and Wildlife Department, 2010a). Red snapper and king mackerel are more often caught in offshore State waters or in the EEZ. There are also moderate levels of spotted seatrout catch in both areas. The recreational taking of shrimp, crabs, and oysters are also allowed in Texas State waters (Texas Parks and Wildlife Department 2011b).

Table 4-19 presents data on the number of angler trips by geographic area and by whether private boats or charter boats were used. This table confirms that bay fishing comprises the vast majority of angler trips on the coast of Texas, accounting for 95.3 percent of recreational fishing activity in 2010. Fishing in offshore State waters accounted for 3.1 percent of recreational fishing activity in 2010, while EEZ fishing accounted for 1.7 percent. In 2009, bay fishing accounted for 94.2 percent of recreational fishing trips, fishing in offshore State waters accounted for 3.4 percent, and EEZ fishing accounted for 2.3 percent (**Table 4-20**). These slight differences between 2009 and 2010 are likely partially attributable to the DWH event. Private boating accounted for 88 percent of angler trips in 2010, while charter boating accounted for 12 percent.

Economic Effects of the Recreational Fishing Industry

Recreational fishing activity can affect a regional economy in a number of ways. Most directly, anglers affect the economy through 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 launch 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 (USDOC, NMFS, 2010d). Anglers in Texas spent $2.2 billion in 2009. This spending level was similar in scale to spending by anglers in Louisiana.

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 actors 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, 2010d); this analysis utilizes many of the techniques of an earlier study by Gentner and Steinback (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. Total sales refers to the sum of all transactions that occur due to direct spending, while value added refers to the sum of the additional production that occurs at each step along a supply chain. **Table 4-21** illustrates that the $2.2 billion in direct expenditures resulted in $2.8 billion in total sales activity and $1.4 billion in value added in Texas. This spending also helped to support over 22,000 jobs in the region.

Deepwater Horizon Event

The majority of the impacts of the DWH event were felt in the Gulf waters east of Texas. However, 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. **Chapter 4.1.1.15** provides more information on the effects of the DWH event on fish habitats. In addition, there could have been substitution of fishing activity away from the central Gulf towards Texas as a result of the spill. Conversely, some fishermen may have cancelled fishing trips in Texas due to concerns regarding the safety of the fish in the WPA. The Texas Parks and Wildlife Department produces seasonal recreational fishing data that can provide overall measures of the scale of some of these effects (Texas Parks and Wildlife Department, 2011a). Namely, the Texas Parks and Wildlife Department has historically divided its data collection into two seasons: low season (November 21 through May 14) and high season (May 15 through November 20). Since the DWH event occurred at the very end of the low season, the data for the May 15 through November 20 period in 2010 should provide an overall sense of the extent to which recreational fishing activity was impacted in the immediate aftermath of the spill.

Table 4-22 presents landings data for the most often caught species in Texas during each season in 2009 and 2010. Panel A presents overall catch data in Texas, while Panels B, C, and D present catch data for Texas bays and State and Federal waters. As can be seen in Panel A, the DWH event did not drastically change the overall number of landings for most species. This is likely because the vast majority of recreational fishing activity in Texas occurs in nearshore bays, which were quite distant from the DWH site. Indeed, species such as red drum, black drum, Atlantic croaker, and sand seatrout had a somewhat higher number of landings during the second season of 2010 compared with the same period in 2009. However, species such as king mackerel and red snapper, which are typically caught in State and Federal waters, did experience a decrease in landings. **Table 4-22** presents data on angler trips in each of the two seasons in 2009 and 2010. Overall, angler trips in Texas during the May to November period fell slightly from approximately 712,000 trips in 2009 to 702,000 trips during 2010. This decrease in overall angler trips was due to a decrease in fishing trips in State and Federal waters. However, the number of fishing trips in nearshore bays slightly increased from 656,000 to 661,000. Thus, as of yet, it does not appear that the DWH event has drastically changed the level of recreational fishing activity in Texas. However, BOEM will continue to monitor fishing activity in Texas and will update its baseline estimates as new information becomes available.

4.1.1.17.2. 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 commercial species. The effects of routine OCS activities on commercial fishing are discussed in **Chapter 4.1.1.16.2**. 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 4.2.1.15**.

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). However, even if a space-use conflict were to arise in a particular instance, it is likely that a number of substitute recreational fishing sites would be available. In addition, the scale of any particular OCS action relative to the overall size of these economies is fairly small.

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. 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. Texas currently has 47 artificial reef sites that make use of decommissioned oil and gas platforms. The Texas Parks and Wildlife Department has an interactive mapping application that displays the locations of these sites (Texas Parks and Wildlife Department, 2010b). 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 WPA proposed action will lead to 15-23 oil and gas production structures (**Table 3-2**). This could lead to minor space-use conflicts with recreational fishermen, primarily during the construction phase. A WPA 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 4.1.1.16.2**. However, these effects are expected to be minimal, particularly given the small scale of a WPA 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 significantly change during upcoming years.

Summary and Conclusion

There may be minor space-use conflicts with recreational fishermen during the initial phases of a WPA proposed action. A proposed action may also lead to low-level environmental degradation of fish habitat, which would negatively impact recreational fishing activity. However, these minor negative effects would likely be outweighed by the beneficial role that oil rigs serve as artificial reefs for fish populations. The degree to which oil platforms will become a part of a particular State's Rigs-to-Reefs program will be an important determinant of the degree to which a WPA proposed action will impact recreational fishing activity in the long term.

4.1.1.17.3. 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 4.1.1.15.3**. The fish species most important to recreational fishing in certain regions are discussed in **Chapter 4.1.1.17.1**. 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 4.1.1.16.3**. The majority of recreational fishing in Texas occurs in the bays and wetlands areas along the Gulf Coast; the impacts of accidental events on wetland areas are described in **Chapter 4.1.1.4.3**.

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), Haab et al. (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.

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 WPA proposed action would result in an estimated 27-40 total (all depths) producing oil wells, 4-6 of which would be in waters <100 m (328 ft); 36-62 producing gas wells, 22-37 of which would be in waters <60 m (197 ft); and 15-23 installed production platforms, 10-17 of which would be in waters <60 m (197 ft) (**Table 3-2**). 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 4-22**, spotted seatrout, red drum, black drum, Atlantic croaker, and sand seatrout are the species most likely to be affected by a spill reaching the Texas coast. A spill farther from shore would primarily affect 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.

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 noticeable 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.

4.1.1.17.4. Cumulative Impacts

Background/Introduction

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. These impacts will arise from the cumulative effects on fish resources in the Gulf of Mexico, which are discussed in **Chapter 4.1.1.15.4**. 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 4.1.1.16.4** 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 will 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 WPA 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 (GMFMC); their most recent policies are outlined in GMFMC (2011). Each State has its own guidelines for recreational fishing in State waters. Texas's fisheries management policies can be accessed on the Internet website of the Texas Parks and Wildlife Department (2011b); the fisheries management policies of Louisiana, Mississippi, Alabama, and Florida 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, 2010a). 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 WPA proposed action will 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. 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. Texas currently has 47 artificial reef sites that make use of decommissioned oil and gas platforms. The Texas Parks and Wildlife Department has an interactive mapping application that displays the locations of these sites (Texas Parks and Wildlife Department, 2010b). 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.

Deepwater Horizon Event

The DWH event may heighten the sensitivity of recreational fishing activity in the WPA to additional oil spills that may occur. Texas, however, had no fisheries closure areas as a result of the DWH event. Any negative effects on recreational fishing or charter fishing in Texas are partly due to the perception of fisheries damage or fish flesh tainting from this spill. The actual damage to fish populations is still to some extent unknown, as addressed in **Chapters 4.1.1.15.4 and 4.1.1.16.4**.

The damage to recreational fisheries 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. However, since the majority of the impacts of the DWH event were felt in the CPA and in Florida, these lingering effects are more likely to be felt in those areas.

Summary and Conclusion

A WPA 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 WPA proposed action to these positive and negative cumulative effects would be minimal because of the relatively small amount of activity expected with a WPA 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.

4.1.1.18. Recreational Resources

This chapter will discuss the potential impacts of OCS oil and gas activities on resources that are particularly important to the local recreation and tourism economies in the WPA. Routine OCS actions in the WPA 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 WPA proposed action on recreational activities are likely to be small in scale since a proposed action does not significantly raise the probability of another spill along the lines of the DWH event.

4.1.1.18.1. Description of the Affected Environment

A WPA 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. 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. This section discusses the baseline conditions for recreational resources along the coast of Texas since this is the primary region that could be impacted by a WPA proposed action. The baseline conditions for recreational resources along the coasts of Louisiana, Alabama, Mississippi, and Florida are described in **Chapter 4.1.1.18.1**. The economic significance of the recreation and tourism industries in the coastal zone of Texas is presented first; this is followed by a more in-depth discussion of the recreational industry in Texas. The final section provides a brief discussion of the impacts of the DWH event on the recreational economy of Texas; however, a broader discussion of the DWH event is presented in **Chapter 4.1.1.18.1** since the effects of the spill on baseline conditions for recreational resources in Texas were minimal.

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 Economic Impact Areas (EIA's); these regions are defined in **Figure 4-20**. (All employment data were obtained from 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 310,000 people worked in the leisure/hospitality industry in the Texas EIA's in 2009. TX-3, which includes the Houston and Galveston areas, has by far the largest recreational industry with approximately 240,000 workers in 2009. TX-1, which includes the areas around South Padre Island and Corpus Christi, has approximately 53,000 recreation workers. TX-2 has around 16,000 workers in the recreation industry, primarily driven by the recreational resources in Brazoria and along Matagorda Bay. Recreational employment in all three EIA's exhibited steady growth from 2001 through 2007; employment in these regions generally fell in 2008 and 2009 with the onset of the global economic downturn during that time. Hurricane Ike, which hit the Texas coast in September 2008, caused a good deal of damage to the Galveston Island region. Recreational employment in Galveston County fell from 14,200 in December 2007 to 12,500 in December 2008; employment had recovered to a level of 13,610 by December 2009 (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010a).

Panel B of **Table 4-23** presents the number of employees in recreation/tourism in the EIA counties/parishes that are directly along the Gulf Coast. These counties/parishes are particularly vulnerable to the effects of an oil spill such as the DWH event. Recreational employment in coastal counties in Texas is noticeably lower than in EIA's; this is primarily due to the fact that Harris County, home to Houston, does not border the Gulf of Mexico. Panel C of **Table 4-23** presents data on the total number of jobs in the recreation and tourism industries in each state; Texas EIA counties account for approximately one-third of the recreational employment in Texas. **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, recreation workers in Texas EIA counties earned approximately $5.6 billion, which is second only to Florida among the Gulf Coast States. Wages in Texas did not fall in 2008 and 2009 along with the slight fall in employment, although the growth in total wages slowed to some extent. It is worth noting that lower than average wages, particularly in TX-1 and TX-2, caused Texas total wages to represent a somewhat smaller fraction of total Gulf Coast wages than of Gulf Coast employment (the average salary of workers can be closely approximated by dividing total wages by total employment in any geographic region).

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 Texas spent approximately $50.9 billion in 2008 and $47.2 billion in 2009. This decline in tourism spending in 2009 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 more sensitive to OCS activities, particularly in the event of an oil spill, than would recreational activities far inland. This is particularly true for some of the resources along the vast barrier island system along the coast of Texas. 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 identify approximately 14,000 of these jobs in Texas that support a payroll of approximately $370 million. 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. However, Kaplan and Whitman still provide a rough sense of the scale of coastal recreational employment in each state from a unique perspective. Namely, this narrowly defined measure of jobs sheds particular light on the potential scale of effects that events such as oil spills are likely to have on a broader group of activities. It is also of use to identify the most at risk jobs in a particular area since the data can provide a rough 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 more positive way in which OCS activity can affect recreation is through the effect of oil and gas structures themselves. Namely, there is substantial recreational activity associated with these structures in the Gulf of Mexico from Alabama through Texas, and these activities have a considerable economic impact. An Agency-funded study to determine the economic contribution of rig-associated recreational activities estimated that a total of 980,264 fishing trips were taken within 300 ft (91 m) of an oil or gas structure or an artificial reef created from such structures during 1999 out of a total 4.48 million marine recreational fishing trips in the Gulf, about 22 percent of the total (Hiett and Milon, 2002). While rigs as reefs contribute substantially to fishing, they are also the destination for the vast majority of recreational diving trips. The study found that there were 83,780 dive trips near oil and gas structures out of a total 89,464 dive trips taken, about 93.6 percent of the total. Overall, the study estimated a total of $172.9 million in trip-related costs for fishing and diving near oil and gas structures, with $13.2 million in trip expenditures for diving and $159.7 million associated with trip expenses for recreational fishing (Hiett and Milon, 2002). A more detailed discussion of the affected environment for recreational fishing can be found in **Chapter 4.1.1.17.1**.

Recreational Resources on the Texas Gulf Coast

The Texas Gulf Coast is home to a diverse set of recreational resources that support a large recreational industry. Dean Runyan Associates (2010) estimates that tourists spent $14.5 billion on the Texas Gulf Coast in 2009. The Gulf Coast counties with the largest concentration of recreation workers (over 10,000 workers) in the Gulf Coast region of Texas are Hidalgo, Cameron, Nueces, Fort Bend, Galveston, Harris, and Jefferson (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010a). Harris County has a particularly large concentration of approximately 175,000 workers. **Table 4-27** presents a detailed breakdown of tourism spending in Texas (Dean Runyan Associates, 2010). As can be seen, accommodation services, food services, and transportation services each accounted for over $2 billion in Gulf Coast recreation spending in 2009. Visitor retail sales accounted for about $1.7 billion, while direct spending on entertainment-related services accounted for approximately $1.4 billion.

The vast majority of tourism and recreation in the Texas Gulf Coast occurs in five Metropolitan Statistical Areas (MSA's): Brownsville/Harlingen, Corpus Christi, Victoria, Houston/Baytown/Sugar Land, and Beaumont/Port Arthur. **Table 4-28** presents information on the number of visitors and the level of visitor spending in each MSA; the number of visitors comes from D.K. Shifflet and Associates (2010a), while visitor spending comes from Dean Runyan Associates (2010). As can be seen, the Houston/Baytown/Sugarland region is by far the largest tourist destination on the Texas Gulf Coast, attracting approximately 30 million visitors and over $12 billion in visitor spending in 2009. This region includes Galveston Island, a major source of beach tourism; the two major beaches in Galveston are Stewart Beach and East Beach. Texas has 168 beaches in total (**Table 4-29**) that attract approximately 5 million visitors annually (USEPA, 2008c). Galveston Island is also home to Moody Gardens, an entertainment park that includes a vast array of nature-based recreational opportunities. Galveston Island was the area most directly impacted by Hurricane Ike's landing in September 2008. Hurricane Ike damaged some recreational resources, including Galveston Island State Park (Texas Parks and Wildlife Department, 2010c). Galveston tourism as a whole, however, seems to be recovering reasonably well from the storm. For example, in Summer 2010, hotel tax receipts in Galveston increased by 20 percent in May, 34 percent in June, and 32 percent in July, compared with receipts in Summer 2009; this left hotel receipts only about 15 percent below receipts in Summer 2008 (Galveston.com, 2010).

Corpus Christi Bay is the second largest recreational area on the Texas Gulf Coast, attracting over 6 million visitors and over $1 billion in spending annually. Some of the main attractions of the Corpus Christi area include the Texas State Aquarium and the USS *Lexington* Museum; estimates of the number of visitors to these and other recreation sites in Texas can be found in D.K. Shifflet and Associates (2010b). Mustang Beach and Mustang Island State Park are located in the barrier island system directly off the coast of Corpus Christi Bay. The Padre Island National Seashore is located in the barrier island system south of Mustang Island; The Padre Island National Seashore is a vast stretch of largely undeveloped land that is home to a wide variety of birding and fishing opportunities. The Corpus Christi area is at the center of a vast system of birding trails in Texas; more information can found through the Texas and Parks and Wildlife Department. Nature watching is also a particularly important component of the economy of Texas, attracting 2.9 million in spending annually (USDOI, FWS and USDOC, Census Bureau, 2006).

South Padre Island, located on the southernmost coast of Texas near Harlingen, is one of the major beach recreation areas on the Gulf Coast and is a driver of much of the local economy. The recreation economies of Victoria MSA and Beaumont/Port Arthur MSA are primarily driven by some of the parks and national wildlife refuges in or near these regions; examples of these include Aransas National Wildlife Refuge, Matagorda Island State Park, San Bernard National Wildlife Refuge, Brazoria National Wildlife Refuge, Anahuac National Wildlife Refuge, McFaddin National Wildlife Refuge, and Big Thicket National Preserve. Estimates of the economic significance of some of these areas can be found in Kaplan and Whitman (2008); the geographic location of these areas can be found using the National Oceanic and Atmospheric Administration's ERMA mapping system (USDOC, NOAA, 2010n). Additional geographic information regarding any particular park, as well as information regarding the management of these areas, can be found using the online, interactive mapping application provided by the National Marine Protected Area Center (2011).

Deepwater Horizon Event

The DWH event and resulting oil spill primarily caused indirect impacts in Texas that appear to be fairly small in scale. The vast majority of the spilled oil stayed off the coast of Louisiana and other eastern Gulf States. While there were scattered reports of tarballs in areas such as Galveston Island (AOLnews, 2010), the findings were of such a small scale that significant direct impacts on tourism are unlikely. However, some indirect effects are likely to have occurred. For example, some tourists may have stayed away from Texas Gulf Coast beaches due to misperceptions regarding the extent to which these beaches were damaged due to the spill. Conversely, there may have been some substitution of beach visitation away from beaches in the eastern Gulf towards the beaches in Texas, which were farther from the spill. While it is difficult to quantify these effects, some anecdotal evidence regarding this substitution effect can be found in Pack (2010). Hotel occupancy data suggest that these two effects may have largely offset each other. Source Strategies Inc. (2010) reports that total hotel occupancy in the three metro regions closest to the Gulf Coast increased just 1.9 percent during the third quarter of 2010 compared with the third quarter of 2009.

Damage claims data also suggest that the effects of the DWH event on the Texas recreational industry were relatively small in scale. **Table 4-30** presents data on the amount of damages paid to individuals and businesses by the Gulf Coast Claims Facility in different industries (Gulf Coast Claims Facility, 2011a). As of April 9, 2011, $27.8 million had been paid to individuals and $90.9 million had been paid to businesses in Texas. This represents a small fraction of the approximately $3.8 billion in damage payments that have been paid throughout the Gulf Coast. Claims in Texas were primarily concentrated in the fishing; seafood processing and distribution; retail sales and service; and food, beverage, and lodging industries. Direct claims in the tourism/recreation industry were only $160,000, although some of the indirect impacts felt by other industries were tourism related.

Employment and wage data also do not suggest significant structural change in the recreation industry in Texas as a result of the DWH event. **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 subindustries such as entertainment providers, lodging services, and food/beverage services. As can be seen, employment remained relatively stable in each of Texas' EIA's in the months following the DWH event. Namely, the combined employment in the leisure/hospitality industry in the three Texas EIA's increased 1.3 percent from March 2010 to September 2010. **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**. As can be seen, wages slightly increased in the third quarter of 2010 compared with the third quarter of 2009. Thus, the available economic data suggest that the structure of the recreational industry in Texas has not significantly changed following the DWH event. In addition, any minor fluctuations in employment and wages that did occur in localized areas are likely to be transitory since the physical recreational resources along the Texas coast were generally unharmed.

4.1.1.18.2. 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) 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 are conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. The BOEM policy regarding marine debris prevention is outlined in NTL 2007-G03 (USDOI, MMS, 2007c). 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 (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 constructed along with OCS activities 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 and to continue to serve as artificial reefs after oil production has ceased; Dauterive (2000) provides an overview of these programs. McGinnis et al. (2001) also discuss 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 on the impacts of routine OCS actions on recreational fishing activity can be found in **Chapter 4.1.1.17.2**.

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 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. Space-use conflicts would be a particular concern near the Galveston/Houston area, which is home to both a large recreational economy and to a large amount of oil and gas processing facilities. An economic analysis of the various uses of Galveston Bay can be found in Ko (2007).

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 WPA 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 affects 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. 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. 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 WPA 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 WPA proposed action would result in 27-40 oil wells, 36-62 gas wells, and 15-23 installed production platforms. Marine debris would be lost from time to time from OCS operations associated with drilling activities projected to result from a WPA proposed action. However, the various laws, regulations, and NTLs related to the discharge of marine debris are expected to keep these discharges to a low level. A WPA proposed action is expected to result in 64,000-75,000 service-vessel trips and 290,000-605,000 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.

The broader economic implications of a WPA proposed action would be felt primarily on the Gulf Coast of Texas. The Texas coastline features an important barrier island system that supports a broad range of beach-related activity. As such, policymakers should be cognizant of the visual, debris, and noise related issues that could impact beach-related activity at these locations. However, given the expansive oil and gas industry already in place, as well as the distance oil platforms in Texas maintain from shore, beach-related disruptions due to OCS operations are expected to be minimal. As discussed in **Chapter 4.1.1.18.3**, the EIA associated with the Houston region is likely to feel the most direct effects from any increase in employment associated with a WPA proposed action. However, given the size of Houston's economy relative to a proposed action, there is unlikely to be any noticeable crowding out of recreational resources in the region. Similarly, impacts of routine activities on property values and tourism are likely to be small since a WPA proposed action does not substantially change the structure of OCS operations in the Gulf of Mexico.

Summary and Conclusion

Routine OCS actions in the WPA 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 WPA proposed action has the potential to directly and indirectly impact recreational resources along the coast of Texas. However, the small scale of a WPA 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.

4.1.1.18.3. 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, 2010o). 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, 2010n). The ESI maps also provide point indicators for recreational resources. 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. This is 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 Graham (2010). 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 at having been cleaned, there were still ongoing cleanup operations at certain segments of all of these locations. Wang and Roberts (2010) presents 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 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, 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 of the spill; it also caused some aesthetic impacts to the experiences of tourists in the region (Tuler et al, 2010).

The DWH event was much more significant in size and duration than the spills previously mentioned. 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 DHW 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, 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, 2011a). For example, the bulk of the claims by individuals have been made in the food, beverage, 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. 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. 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.

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 WPA proposed action. The beach areas with a 1 percent chance or greater of being impacted by an oil spill are as follows (the 10-day and 30-day probabilities are both presented, respectively): the Texas Coastal Bend beach area (1% and 2-4%); the Matagorda beach area (2-3% and 3-5%); and the Galveston Beach area (1-2% and 2-4%). The ESI maps of the Texas coastline can be found using the National Oceanic and Atmospheric Administration's ERMA mapping system (USDOC, NOAA, 2010n). 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). The coasts of the inland bay systems in Texas, as well as much of the coast of Louisiana, have a number of marsh areas, which would be even more difficult to clean in the event of a spill reaching these areas. The inland bay system in Texas is particularly important for recreational fishing activity; more information on recreational fishing in Texas can be found in **Chapter 4.1.1.17.1**. **Figures 3-27 and 3-29** display the probabilities of oil spills ≥1,000 bbl occurring and contacting certain recreational diving areas as a result of a WPA proposed action. The recreational diving areas with a 1 percent chance or greater of being impacted by an oil spill are as follows (the 10-day and 30-day probabilities are both presented, respectively): the Port Lavaca Liberty Ship reef (2-3% and 2-4%); the High Island area (1% and 1-2%); and the West Cameron area (1% and 1-2%).

Summary and Conclusion

Spills most likely to result from a WPA proposed action will 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 will 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 significant.

4.1.1.18.4. Cumulative Impacts

Background/Introduction

The cumulative impacts to recreational resources will occur through a WPA proposed action, the existing OCS Program, and from the expected impacts of external events and actions to recreational resources and tourism activity. A WPA proposed action will 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 will contribute to the incremental impacts of an oil spill, should one arise from a WPA proposed action.

Aesthetic Impacts

A WPA 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. The regulation and enforcement of these laws are conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. The BOEM policy regarding marine debris prevention is outlined in NTL 2007-G03 (USDOI, MMS, 2007c). 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 WPA 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 WPA 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. Space-use conflicts would be a particular concern near the Galveston/Houston area, which is home to both a large recreational economy and to a large number of oil and gas processing facilities. An economic analysis of the various uses of Galveston Bay can be found in Ko (2007). However, given the small scale of a WPA proposed action relative to the broader OCS Program, as well as relative to the size of these local economies in Texas, the cumulative impacts to space-use conflicts are likely to be minor.

Oil Spills

A WPA 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 WPA proposed action. For example, it is estimated that a WPA proposed action will lead to

<1 spill ≥1,000 bbl. However, oil spills could also arise from the OCS industry that is currently in place in the WPA. Thus, the impacts of accidental events on recreational resources, which are discussed in **Chapter 4.1.1.18.3**, should be viewed in light of the incremental increase in the likelihood of an oil spill that will be associated with a WPA 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, 2011d). 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 4.1.1.3.4**. Further information on the cumulative impacts of OCS activities on wetlands resources can be found in **Chapter 4.1.1.4.4**.

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 significant 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 WPA 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 WPA proposed action would contribute to the aesthetic impacts and 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 WPA 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 WPA 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.

4.1.1.19. 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). The full analyses of the potential impacts of routine activities and accidental events associated with a WPA proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in the following sections. 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 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 WPA 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 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 the WPA proposed action area to determine if additional archaeological resource surveys and mitigation is warranted.

4.1.1.19.1. Historic

4.1.1.19.1.1. Description of the Affected Environment

Historic archaeological resources on the OCS consist of historic shipwrecks and a single historic lighthouse, the Ship Shoal Light. A historic shipwreck is defined as a submerged or buried vessel or their associated components, at least 50 years old, that has foundered, stranded, or wrecked and that is currently lying on or embedded in the seafloor. Ships are known to have traversed the waters of the WPA as early as Captain Alonso Alverez de Piñeda’s expedition in 1519. Alvar Nuñez Cabeza de Vaca is likely to have the dubious distinction of being the first European to be shipwrecked along the Texas coast as early as 1528 (Francaviglia, 1998).

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 mi (1.6 km) of shore and most of the remainder lie between 1 and 6 mi (1.6 and 10 km) of shore (CEI, 1977). Garrison et al. (1989) 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, this Agency 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. Taking the new data into account, the 2003 study recommended including some deepwater areas, primarily on the approach to the Mississippi River, among those lease areas requiring archaeological investigation. With this in mind, this Agency revised its guidelines for conducting archaeological surveys and added about 1,200 lease blocks in the CPA 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 potential shipwrecks have been discovered through oil industry sonar surveys in water depths up to 9,800 ft (2,987 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 WPA 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 515 wrecks in the WPA (**Table 4-33**). 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. Three confirmed historic sites have been positively identified in the WPA through diver visual inspection. These include the Civil War gunboat USS *Hatteras* (41GV68), which currently is listed to the National Register, the early 19th-century steamship *New York* (Irion and Ball, 2001), which was recently salvaged by for-profit treasure hunters (Bowers, 2008), and the Mexican freighter *Oaxaca* sunk by U-boat action in World War II. Nearly all of these have been discovered as a result of BOEM-mandated oil industry surveys.

Submerged shipwrecks off the coast of Texas 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 French explorer Robert Sieur de LaSalle's *La Belle*, a shallow-draft French sailing vessel classified as a *barque longue* lost in 1686 was discovered in Matagorda Bay, Texas, in 1995 (Bruseth and Turner, 2005). 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 organisms 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). Due to the high levels of preservation and the decrease in impacts from anthropogenic and meteorological events (e.g., diving, looting, trawling, hurricanes, etc.), 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 and intense cold fronts 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 52 ft (16 m) of water and has been documented by this Agency (Irion and Anuskiewicz, 1999; Gearhart et al., in press) 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.

Hurricane activity in the Gulf of Mexico has the ability to impact archaeological resources in water depths up to 130 ft (40 m) (Gearhart et al., in press). 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., in press). 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).

4.1.1.19.1.2. Impacts of Routine Events

Proposed Action Analysis

Routine impact-producing factors associated with a WPA proposed action that could affect historical archaeological resources include 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 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.

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 archaeological reports 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.

The placement of drilling rigs and production systems has the potential to cause physical impact to prehistoric and/or 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 3-5**, 1,180-1,690 exploration and delineation wells and 1,450-2,120 development and production wells will be drilled, and 255-324 production platforms will be installed in support of a WPA proposed action. Of these, 1,510-2,180 exploration, delineation, development, and production wells will be drilled, and 240-360 platforms will be installed in water depths of 200 m (656 ft) or less, which is where the majority of blocks currently requiring archaeological survey are located. While the expanded BOEM shipwreck database currently contains 515 reported shipwrecks in the entire western Gulf OCS, this number is believed to represent a fraction of the actual number of ships lost in the WPA. 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 WPA proposed action area. Of the 5,240 lease blocks in the WPA, just over one-quarter (1,459) are leased. There are 1,548 blocks that fall within the Gulf of Mexico Region's high-potential areas for historic resources in the WPA. Of these blocks, 583 are in water depths of 200 m (656 ft) or less and will require a survey at 50-m linespacing. Twenty-three blocks are in water depths that preclude survey with a magnetometer and require a sidescan-sonar survey at no more that a 300-m 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, BOEM's Regional Director may require the preparation of an archaeological report to accompany the EP, DOCD, or DPP, 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 WPA 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 WPA proposed action has the potential to impact historic shipwrecks. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to have impacted the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. Port Mansfield is one of the smaller Texas ports and, although it has been a base for Gulf oil services operations in the past, today it is primarily a fishing community that attracts vacationers from around the State and beyond. Although bay fishing has remained feasible and has been a source of income to the locals, recently the mouth of the port (in addition to the jetties that provide access to the Gulf) has silted to the point that it may close the port (Siegesmund et al., 2008). Therefore, the impacts to the *Santa Maria de Yciar* and *SS Mary* that are directly attributable to traffic and maintenance dredging as a result of the OCS Program are 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 WPA.

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 WPA proposed action will generate steel structures and debris, which will 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 significant 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 magnetometer. With sites that are buried, and therefore more difficult to identify, the preservation potential is higher and, thus, the potential for significant archaeological data is also higher. At the current survey line-spacing requirement of 50 m (164 ft), studies have concluded that a sizeable shipwreck would likely 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 WPA, 959 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 (984-ft) survey interval.

Summary and Conclusion

The greatest potential impact to an archaeological resource as a result of a WPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, and dredging or pipeline project) 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 250.194(c) and 30 CFR 250.1010(c), lessees are required to immediately notify BSEE's Regional Director of the discovery of any potential archaeological resources.

Offshore oil and gas activities resulting from a WPA 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 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 WPA 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.

4.1.1.19.1.3. Impacts of Accidental Events

Proposed Action Analysis

Impacts on historic archaeological resources could occur as a result of an accidental oil spill. A major effect from an oil spill 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 on the sea surface over a wide area and at depth at the Macondo wellhead 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. 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. A recent site investigation of corals approximately 7 mi (11 km) from the Macondo wellhead revealed that the corals were potentially 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). This has implications for the possible oiling of shipwrecks 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 the *Alcoa 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 the 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 an analysis that may aid in interpreting and understanding the archaeological record.

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 a historic archaeological site (including submerged sites), 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. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. It is expected that any spill cleanup operations would be considered a Federal action for the purposes of Section 106 of the National Historic Preservation Act (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). Detailed risk analyses of offshore oil spills ranging from ≥1,000 bbl, ≤1,000 bbl, and coastal spills associated with a WPA proposed action are provided in **Chapters 3.2.1.5**, **3.2.1.6**, **and 3.2.1.7** 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 areas.

The potential for spills is low, the effects would generally be localized, and the cleanup efforts would be regulated. A WPA 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.

4.1.1.19.1.4. 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-reefs 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 linespacing. The potential of an interaction between MODU or platform emplacement and a historic shipwreck is greatly diminished by 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 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 **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. Coastal, oil-spill scenario numbers are presented in **Table 3-21** 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. Should such oil spills contact a historic site, the effects would be temporary and reversible.

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, that issue permits associated with pipelines in State waters are responsible for taking into consideration the effects of agency-permitted actions 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 already would have been 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 a predeployment archaeological survey of sand borrow sites is 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 new-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 the results of 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). On many wrecks, the uppermost portions would already be disturbed by natural processes and would contain artifacts that have lost all original historic context.

Sport diving 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 Texas Historical Commission and the Texas Archeological Stewardship Program (Texas Historical Commission, 2010), would serve to lessen these potential impacts. While commercial treasure hunters generally impact wrecks that have intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. Since the extent of these activities is unknown, the impact cannot be quantified. A Spanish war frigate, *El Cazador*, was discovered in the eastern Gulf of Mexico; 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 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 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, and anchoring activities). 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 300-m (98-ft) 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 grants authority in certain cases to the BSEE and BOEM Regional Directors 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 WPA 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 <660 ft (200 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 will continue to impact historic period shipwrecks.

Development onshore as a result of a WPA 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 will 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 WPA proposed action is expected to be very small due to the efficacy of the required remote-sensing survey 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 WPA proposed action is expected to be very small due to the efficacy of the remote-sensing surveys and archaeological reports, where required.

4.1.1.19.2. Prehistoric

4.1.1.19.2.1. 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 Before Present (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). During periods that the continental shelf was exposed above sea level, the area was open to habitation by prehistoric peoples.

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 landmass 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 before present.

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 Western Planning Area OCS is sparse. The McFaddin Beach Site (41JF50) in Jefferson County, Texas, 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 includes 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 WPA Gulf Coast around 11,500 B.C. (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 archaeological site potential in 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.

Holocene sediments form a thin veneer or are absent over the majority of the continental shelf off western Louisiana and eastern Texas (USDOI, MMS, 1984). Many large, late Pleistocene, fluvial systems (e.g., the Sabine-Calcasieu River Valley) are within a few meters of the seafloor in this area. Farther to the south and west, a blanket of Holocene sediments overlays the Pleistocene horizon. In the western Gulf, prehistoric sites representing the Paleoindian culture period through European contact have been reported. The McFaddin Beach site, east of Galveston in the McFaddin National Wildlife Refuge, has produced late Pleistocene megafaunal remains and lithics from all archaeological periods, including a large percentage of Paleoindian artifacts (Stright et al., 1999). A study funded by this Agency to locate prehistoric archaeological sites in association with the buried Sabine-Calcasieu River Valley was completed in 1986 (CEI, 1986). Five types of relict landforms were identified and evaluated for archaeological potential. Coring of selected features was performed, and sedimentary analyses suggested the presence of at least two archaeological sites. A study funded by BOEM, “Examining and Testing Potential Prehistoric Archaeological Features on the Gulf of Mexico Outer Continental Shelf,” is scheduled for completion in 2012.

Surveys from other areas of the eastern part of the WPA 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.

A good-faith effort was made to identify any impacts to known prehistoric sites in the western Gulf as a result of recent hurricane activity; however, no such information was identified. It is possible that storm activity associated with Hurricane Rita may have impacted prehistoric sites in the shallow-water zone along the relict Sabine River valley because of its proximity to the seafloor surface.

4.1.1.19.2.2. 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 45-m (148-ft) 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, this Agency has adopted the 60-m (197-ft) water depth as the seaward extent of the area considered to have potential for prehistoric archaeological resources.

Offshore development as a result of a WPA 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. The area of seafloor disturbance from each of these structures is defined in **Chapters 3.1.1.2.2 and 3.1.1.3.2**. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric archaeological resources. Pipelines placed in water depths of <60 m (200 ft) must be buried. Burial depths of 1 m (3.28 ft) are required, with the exception of shipping fairways and anchorage areas, where the requirements are 9.84 ft (3 m) and 15 ft (4.6 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 WPA 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 WPA proposed action would require no new oil and gas coastal infrastructure. Any facility constructed must receive approval from the pertinent Federal, State, county/parish, and/or 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 WPA proposed action.

In order to reduce the risk of impacting a prehistoric archaeological resource during a BOEM-permitted activity, BOEM requires 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 WPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, and dredging or pipeline project) 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 surveys, 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 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/or unique archaeological information.

4.1.1.19.2.3. Impacts of Accidental Events

Proposed Action Analysis

Oil spills resulting from a well blowout in the WPA and related spill-response activities have the potential to impact cultural resources near the spill site and landfall areas. 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.

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 WPA proposed action are provided in **Chapters 3.2.1.5**, **3.2.1.6, and 3.2.1.7**, 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 WPA proposed action. A WPA proposed action, therefore, is not expected to result in impacts to prehistoric archaeological sites.

4.1.1.19.2.4. 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 there is no potential for the occurrence of prehistoric archaeological sites in water depths >60 m (197 ft). Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity 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 **Table 3-21** 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/or 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.

Because BOEM does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within BOEM's jurisdiction. Under the NHPA, other Federal agencies, such as COE, that permit pipelines in State waters are responsible for taking into condiseration the effects of permitted activities 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 WPA proposed action is expected to be minimal. Because of continued regulations and surveys, where required, potential impact from a WPA 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 WPA proposed action is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

4.1.1.20. Human Resources and Land Use

4.1.1.20.1. 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 13 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 WPA 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 WPA 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, 2011a). 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 WPA 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**.

4.1.1.20.1.1. 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 WPA are all within Texas and include Brownsville, Corpus Christi, Victoria, Brazoria, Houston-Galveston, and Beaumont-Port Arthur. Since so much of the WPA offshore activities also involve land use and infrastructure in Louisiana, BOEM includes the following Central Planning Area LMA's in this EIS analysis of the WPA: Lake Charles; Lafayette; Baton Rouge; Houma; and New Orleans, Louisiana. 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 (Pulsipher, in preparation). 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 EIS's.

Land Use

For a proposed WPA action, the primary region of geographic influence is coastal Texas and Louisiana. The coastal zone of the northern GOM is not a physically, culturally, or economically homogenous unit (Gramling, 1984a). The counties and parishes along the coasts of Texas and Louisiana 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 4-21 and 4-22 illustrate the analysis area's key infrastructure. Major cities in the analysis area include Houston, Texas, and Lake Charles, Lafayette, Baton Rouge, and New Orleans, Louisiana. Other important cities in the analysis area include Corpus Christi, Galveston, Port Arthur, and Beaumont, Texas. 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, 2010a). 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, 2011a). 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, 10 of the leading 25 U.S. ports ranked by total trade tonnage were located in Texas and Louisiana (American Association of Port Authorities, 2009).

The Gulf coastal plain of Texas makes up most of eastern and southern Texas and constitutes more than one-third of the State. Near the coast, this region is mostly flat and low-lying. It rises gradually to 300 m (1,000 ft) farther inland, where the land becomes more rolling. Belts of low hills occur across the Gulf coastal plain in many areas. In the higher areas, the stream valleys are deeper and sharper than those along the coast. Texas' coastline along the GOM is 367 mi (591 km). However, long narrow islands called barrier islands extend along the coast; if the shoreline of all the islands and bays is taken into account, the coastline is 3,359 mi (5,406 km) long. The region is made up of farmland (cotton, rice, and citrus fruit), forest, cattle ranches, major cities of commerce (e.g., Houston) and education, tourist locales (e.g., South Padre Island), Federal installations (e.g., Lyndon B. Johnson Space Center), and major ports. The oil and gas industry has also been part of the local economies since the early 1900's. Today, the majority of oil and gas corporations have headquarters in Houston, while numerous industries associated with oil and gas (petrochemicals and the manufacture of equipment) are located in the area. In addition to oil and gas, the area has aggressively pursued technology companies such as computers and aerospace. The military has had a significant presence in general, particularly in the Corpus Christi Bay area, and more recently in San Patricio County on the eastern shore of the bay.

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 WPA, 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).

According to the most recent statistics from the U.S. Department of Agriculture's Economic Research Service, which classifies counties into economic types that indicate primary land-use patterns, 2 of the 74 counties/parishes in the analysis area are classified as farming dependent, 9 as mining dependent (suggesting the importance of oil and gas development to these local economies), 17 as manufacturing dependent, 9 as government employment centers, 3 as tied to service employment, and 34 as nonspecialized. The Economic Research Service also classifies counties in terms of their status as a retirement destination; 11 of the 74 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, in press); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, in preparation). 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 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 (3,038 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 4-21 and 4-22 show the geographic distribution of platform fabrication yards across the WPA analysis area. There are 12 platform fabrication yards in Texas, mainly concentrated in the Harris County/Houston area. The BOEM-identified EIA's in Louisiana have the highest concentration of platform fabrication yards (37), the majority of which are located in Jefferson, Terrebonne, and Iberia Parishes.

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 Gulf Coast, can vary considerably depending upon the primary markets these shipyards serve (i.e., commercial or military). The Texas coastal area hosts 32 shipyards and twice as many (64) shipyards are located in Louisiana. **Figures 4-21 and 4-22** show the geographic distribution of shipyards across the WPA 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 4.1.1.20.1.1** discusses OSV's in detail.

Major shipyards in the WPA analysis area include Gulf Copper Manufacturing, Signal International, and Houston Ship Repair in Texas and Bollinger Shipyards in Louisiana.

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 pipecoating companies. Texas contains nine locations. In Louisiana, there are six pipecoating facilities, mainly in Iberia Parish. The remaining 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 WPA analysis area are Bredaro Shaw and Tenaris in Texas, and The Bayou Companies in Louisiana. 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 pipecoating 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 '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, in press); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, in preparation). The major support facilities discussed in the following section include service bases/ports, waste disposal facilities, and natural gas storage facilities.

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 WPA 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 WPA include Galveston, Freeport, and Port O'Connor, Texas, and Intracoastal City, Louisiana.

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 (C**hapters 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 and 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 4-21 and 4-22** show the geographic distribution of waste disposal facilities across the WPA 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 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, 2010a).

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, Texas has 14 salt cavern sites with 78 Bcf of working gas capacity and Louisiana has 7 sites with 48 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 4-21 and 4-22** show the geographic distribution of natural gas storage facilities across the WPA 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 '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, in press); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, in preparation).

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 crewboat 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 of 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 deep water 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 3-6** 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.

OCS Support Vessels

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, in press); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, in preparation).

The primary types of OCS support vessels include anchor handling, towing and supply (AHTS) vessels, 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 Gulf of Mexico is the FPSO, mentioned briefly in **Chapter 4.1.1.20.1.2**.

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 (55 m) long and can carry about 1,200 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 3-10 times more liquid mud, 2-4 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 (23 to 58 m). 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 they 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, fire fighting, 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, and 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 depends 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. Because of the extensive trunklines that parallel the Texas coastline, this ratio is lower in Texas. 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). About 20 percent of the onshore length of OCS pipelines is in Texas. 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 of 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 3-13** gives the numerical distribution of pipeline landfalls by state. **Table 3-16** shows all pipeline landfalls that have occurred since 1996 (USDOI, BOEMRE, 2011c).

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 will result from an individual WPA 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 will 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: Matagorda Island, Texas City, Beaumont and Nederland, Texas; and Amelia, Lake Charles, Gibson, Calumet, and Empire, Louisiana. These barge terminals may also receive oil from State production or imports. **Figures 4-21 and 4-22** illustrate the distribution of barge terminals across the WPA 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, in press); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* (Dismukes, in preparation). 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 4-21 and 4-22** illustrate the distribution of gas processing plants across the WPA 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). 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 WPA 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. Even though it is located in the CPA, Independence Hub is still very relevant to future trends in the WPA. 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, 2011d). 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 lead 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 enroute 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.

These significant regulatory hurdles did not prevent Louisiana's Sabine Pass LNG facility from receiving authorization in May 2011 to export domestically produced natural gas to all LNG importing nations around the world. This means that Sabine Pass LNG will be the first bi-directional LNG processing facility in the U.S. that is authorized to export as well as import LNG (Troy, 2011b).

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. 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 on 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).

The Golden Pass LNG terminal near Sabine, Texas, and its associated 69-mi (111-km) pipeline were formally approved to start operations by the Federal Energy Regulatory Commission. In early March 2011, the receiving terminal's performance tests and the Phase 1 commissioning activities were successfully completed. The Phase 1 operations will allow a send-out capacity of 1 Bcf/day of natural gas. Upon completion of Phases 1 and 2, the terminal will be fully operational and capable of importing 15.6 million tons per year of LNG.

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 Coast States of Alabama, Louisiana, Mississippi, and Texas. About 30 percent of operable refineries are located in Louisiana and Texas alone. Texas has 26 operable refineries with a total capacity of 4.7 million barrels per day, representing almost 27 percent of U.S. operable refining capacity. Louisiana has 18 operable refineries with a total capacity of over 3 million barrels per day, representing 18 percent of U.S. operable refining (USDOE, Energy Information

Administration, 2011f). **Figures 4-21 and 4-22** illustrate the geographic distribution of refineries across the WPA analysis area. **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 EIA's, with a total capacity of 7.2 MMbbl/day (USDOE, 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 1990's 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 5 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 Texas and south Louisiana. The vast majority of petrochemical plants in the WPA are located in Texas (126). **Table 3-13** provides the numerical distribution for each state in the analysis area. **Figures 4-21 and 4-22** illustrate the geographical distribution of petrochemical facilities across the WPA 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.

The Houston area is one of the world's largest manufacturing centers for petrochemicals. The Port of Houston is home to a $15 billion petrochemical complex, which is the largest in the Nation. The Houston Ship Channel houses 40 percent of the U.S. petrochemical manufacturing plants. It is also home to the several thousand miles of product, liquefied petroleum gas, natural gas liquids, and natural gas pipelines connecting 200 chemical plants, refineries, salt domes, and fractionation plants along the Texas Gulf Coast. The city of Houston also provides easy access to four ports that make the area's petrochemicals accessible to the world.

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 have removed a large portion of their equipment from Port Fourchon, 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, 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 the demand for services. For example, the impacts of the suspension and permitting delays have been 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 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 continues 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 WPA 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 WPA 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). Fifteen waste staging areas spread out across Louisiana, and there are no waste staging areas in Texas. No decontamination areas were set up in either Louisiana or Texas. 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).

4.1.1.20.1.2. 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 WPA 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 discusses projected new coastal infrastructure that may result from a WPA 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 will occur, and/or COE, and/or USEPA. According to the scenario analysis in **Chapter 3.1.2**, the construction of 0-1 new gas processing facilities would be expected to occur near the end of the 40-year life of a single WPA lease sale. Most of the projected 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 WPA proposed action. According to these BOEM projections, no other new coastal infrastructure would be expected to result from a single WPA proposed action. Given the uncertain environment of the post-DWH event, the application of the scenario is very conservative since the likelihood is diminished that any new gas processing facility or pipeline landfall would result from a single WPA 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 the 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 WPA 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, the potential for a new waste facility as a result of a proposed WPA action is highly unlikely.

Chapters 4.1.1.20.1.1 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 few 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. For example, in Texas, the average daily processing capacity per plant increased from 66 MMcf to 95 MMcf between 1992 and 2006 (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 WPA proposed action (Dismukes, official communication, 2011a).

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 WPA 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 WPA 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 4.1.1.3.2 and 4.1.1.4.2 provide a detailed discussion of coastal barrier beaches and wetlands, respectively, and potential pipeline landfall impacts to those resources.

Chapters 4.1.1.20.1.1 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 WPA 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 WPA are Galveston, Freeport, and Port O'Connor, Texas; and Cameron, Fourchon, Intracoastal City, Morgan City, and Venice, Louisiana.

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, in press). High demand for OSV's translates into a positive impact on OCS-related employment (see **Chapter 4.1.1.20.3.2**, "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, in press). 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 will 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 any additional traffic generated by a WPA 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 single 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 WPA 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 WPA proposed action because the existing system of navigation channels is projected to be adequate to allow proper accommodation for vessel traffic that will occur as a result of a WPA 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, in press). **Chapter 4.1.1.4.2** provides a detailed discussion of wetlands and the impacts of navigation channel dredging.

Chapters 4.1.1.20.1.1 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., 2007). 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, in preparation). 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 4.1.1.20.4.2** provides a discussion of environmental justice issues related to waste disposal facilities.

Summary and Conclusion

The impacts of routine events associated with a WPA proposed action are uncertain due to the post-DWH 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 WPA proposed action. However, based on the most current information available, there is only a very slim chance that either would result from a WPA 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 WPA proposed action. If drilling activity recovers post-DWH event and increases, there may be new increased demand for a waste disposal services as a result of a WPA proposed action. Because of the current near zero estimates for a pipeline landfall and gas processing facility construction, the routine activities associated with a WPA 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 will 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 WPA proposed action.

4.1.1.20.1.3. Impacts of Accidental Events

Proposed Action Analysis

Accidental events (impact-producing factors) associated with a WPA 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. Detailed analysis of a high-impact, low-probability catastrophic event such as the DWH event is provided in **Appendix B**.

Oil spills may be associated with exploration, production, or transportation activities that result from a WPA proposed action. Detailed risk analysis of offshore oil spills ≥ 1,000 bbl, <1,000 bbl, and coastal spills associated with a WPA 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 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 BOEM report, *Oil Spill Risk Analysis: Gulf of Mexico Outer Continental Shelf (OCS) Lease Sales,* *2012-2017, and Gulfwide OCS Program, 2012-2051*, contains the estimated number of oil spills that could happen in Gulf coastal waters as a result of an accidental event associated with a WPA proposed action (Ji et al., in preparation). 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 WPA proposed action are also presented in **Table 3-12**.

Vessel collisions may be associated with exploration, production, or transportation activities that result from a WPA 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, collisions 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 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). A more recent event involved an oil tanker and towing vessel pushing two barges that collided January 23, 2010, in the Sabine Neches Waterway near Port Arthur, Texas. The lead barge tore a hole in the side of the tanker, spilling approximately 450,000 gallons of crude oil in the Port of Port Arthur area (Gonzales and Manik, 2010). The waterway was closed to traffic for several days. One of four major refineries in the area significantly scaled back production until the waterway was reopened to limited traffic January 27, 2010 (Seba, 2010). While neither event involved OCS-related transportation and while both caused unusually large spills, they are examples of the types of accidental spills most likely to affect land use and infrastructure.

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a WPA 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/drilling fluid 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. Although available evidence indicates that the DWH event resulted in only limited, if any, direct impacts on land use and infrastructure in the WPA, the event could be instructive for what impacts may result in the event of another catastrophic spill should it reach the WPA. In the months following the DWH event, there have been some short-term, indirect impacts on land use and coastal infrastructure caused by the drilling suspension imposed on July 12, 2010, by changes in Federal requirements for drilling safety, and the pace of the permit approval process. Drilling has 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 approvals of deepwater permits. The rate of drilling is dependent upon compliance with more stringent Federal enforcement and the industry's efforts to fulfill new safety requirements. 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 4.1.1.20.3** 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 WPA 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 WPA 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). Fifteen waste staging areas were spread out across Louisiana, and there were no waste staging areas in Texas. No decontamination areas were set up in either Louisiana or Texas. 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 4.1.1.20.4.2** provides an additional discussion of environmental justice issues related to the DWH event's waste stream. A detailed analysis of a high-impact, low-probability catastrophic event such as the DWH event can be found in **Appendix B**.

Summary and Conclusion

Accidental events associated with a WPA proposed action occur at different levels of severity, based in part on the location and size of the 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, high-impact 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, Bureau of Transporation Statistics, 2010). The indirect effects on infrastructure use are still rippling through the industry, but this should resolve as issues with the moratorium, 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, high-impact catastrophic event. For the reasons set forth in the analysis above, the kinds of accidental events that are likely to result from a WPA 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.

4.1.1.20.1.4. Cumulative Impacts

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 4.1.1.20.1.1** 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's 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 WPA 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 WPA 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 are also 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 suspension. 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 consequences on petroleum activities. Hence, these events are not expected to effect land use and infrastructure in the cumulative case. The BOEM continues to monitor resources for changes that are applicable to land use and infrastructure.

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 WPA proposed action (i.e., a single OCS lease sale). 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 WPA. 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; that is, 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, in preparation). For example, in Texas the average daily processing capacity per plant has increased from 66 MMcf to 95 MMcf between 1992 and 2006 (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 WPA proposed action (Dismukes, official communication, 2011a). 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 Galveston, Texas; and Port Fourchon, Louisiana for the WPA. There is sufficient land designated in commercial and industrial parks and adjacent to the Galveston 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 exploration 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 will 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 has 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 for 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 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 Galveston, Texas, 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 WPA 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 WPA 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 WPA proposed action to the cumulative impacts on land use and coastal infrastructure are also expected to be minor.

The coastal infrastructure supporting a WPA proposed action represents only a tiny portion of the coastal land and infrastructure throughout the WPA and Gulf of Mexico, and little change is expected to occur due to changing agricultural and extractive (e.g., lumbering and petroleum) uses of onshore land. Many non-OCS-related factors contribute substantially to the cumulative impacts to land use and coastal infrastructure, including 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 WPA proposed action, the cumulative impacts on land use and coastal infrastructure are also expected to be minor.

4.1.1.20.2. 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 WPA 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 4.1.1.16, 4.1.1.17, and 4.1.1.20.3**), 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 WPA proposed action is projected to minimally affect the demography of the analysis area. Population impacts from a WPA 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 4.1.1.20.2.1** below are expected to remain unchanged as a result of a WPA proposed action. The increase in employment discussed in **Chapter 4.1.1.20.3.2** 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 WPA proposed action, such as oil or chemical spills, blowouts, and vessel collisions, would likely have no effects on the demographic characteristics of the Gulf Coast communities. The cumulative activities are projected to minimally affect the analysis area's demography.

4.1.1.20.2.1. Description of the Affected Environment

The BOEM examines demographic and economic impacts over the 40-year life of a WPA 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 4.1.1.20.2**. However, this information does not change the Woods & Poole Economics, Inc. baseline demographic and employment projections used to analyze the impacts of a proposed WPA lease sale and of the OCS Program, which, as explained in **Chapter 4.1.1.20.3.4**, 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 WPA proposed lease sale recognizes that most of the employment that results from industry activities that result from the proposed 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 BOEM 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' 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 area is used to examine leasing activities in both 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 in the region 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 economic impact areas are used to analyze proposed lease sales in both planning areas, the levels of economic impacts to the different individual EIA's do vary between WPA and CPA lease sales. The proposed CPA lease sale is projected to have a greater employment impact for EIA's in both the CPA in the WPA; however, for a WPA proposed lease sale, slightly more than half of the 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.

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 and Fischetti, 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).

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). 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, subsequent NMFS fishing closures and the subsequent drilling suspension. However, these data still remain the best long-term forecast of regional trends for socioeconomic impact analyses of a WPA 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 constituted 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 4.1.1.20.4.1**.

Table 4-48 presents the baseline population projections used to analyze the impacts of a WPA proposed action and of the OCS Program (which, as explained in **Chapter 4.1.1.20.2.4** 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, subsequent NMFS fishing closures and the subsequent drilling suspension). However, these data still remain the best long-term forecast of regional trends for socioeconomic impact analyses of a WPA proposed action.

4.1.1.20.2.2. Impacts of Routine Events

Background/Introduction

The addition of any new human activity, such as oil and gas development resulting from a WPA 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 WPA 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 WPA proposed lease sale are calculated by multiplying the employment projections for the lease sale (**Chapter 4.1.1.20.3.2**) by the average household size of 2.59 persons from the 2010 U.S. Census (USDOC, Census Bureau, 2010) (**Tables 4-49**). The BOEM estimates that, for every one person currently or projected to be employed in OCS-related activities as a result of a WPA proposed action, 1.59 persons in their household would contribute to demographic changes..

A WPA 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 WPA proposed action are projected to peak for each EIA in different years. For the low projection, the population is expected to grow by 6,653 persons in TX-3, FL-4, and all of the Louisiana EIA's during the peak impact year (2015). The population is expected to grow by 837 persons in TX-2, FL-1, FL-2, and FL-3 during the peak impact year (2018). For the low scenario where 2027 is the peak impact year, TX-1, AL-1, and MS-1 are expected to grow in population by 1,181 persons. For the high scenario where 2015 is the peak year, population is projected to increase by 4,642 persons in all of Florida, Alabama, and Louisiana EIA's, and in TX-1. And, for the scenario where the peak year is 2017 for the high projection, TX-3 is expected to increase in population by 8,034 persons as a result of a WPA proposed action. During the 2027 peak year scenario, TX-1 and all of the EIA's in Mississippi are projected to grow by 1,709 persons. During these years, a substantial amount of platform and pipeline installations are projected in association with the 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 4.1.1.20.3.2**. Population impacts from a WPA 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 WPA 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 4.1.1.20.2.1** is expected to continue through the life of a WPA proposed action. A WPA 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 WPA proposed action. **Chapter 4.1.1.20.4.2**, "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 WPA proposed action, the racial distribution pattern described above in **Chapter 4.1.1.20.2.1** is expected to continue through the life of a WPA proposed action.

Summary and Conclusion

A WPA proposed action is projected to minimally affect the demography of the analysis area. Population impacts from a WPA 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 4.1.1.20.2.1**, are expected to remain unchanged as a result of a WPA 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.

4.1.1.20.2.3. 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 WPA 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 4.1.1.20.3**), employment impacts to commercial fishing (**Chapter 4.1.1.16**), recreational fishing (**Chapter 4.1.1.17**), and tourism and recreation (**Chapter 4.1.1.18**) are discussed in detail within their individual sections. Therefore, accidental events associated with a WPA 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 WPA 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 WPA 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.

4.1.1.20.2.4. 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 WPA 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 WPA 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. 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 4.1.1.20.3.4**.

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 4.1.1.20.2.1** would likely continue throughout the analysis period.

Race and Ethnic Composition

Cumulative activities are projected to leave the racial distribution of the analysis area 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 4.1.1.20.2.1** 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 4.1.1.20.2.1**, 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 WPA 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 WPA proposed action, it is expected that the baseline age and racial distribution pattern will continue through the analysis period.

4.1.1.20.3. Economic Factors

This chapter will examine the potential impacts of a WPA proposed action on the economies in the coastal zone of the Gulf of Mexico. The BOEM has defined the EIA's that will be the basis for producing statistical estimates of the employment impacts of a WPA proposed action. The BOEM uses the mathematical model MAG-PLAN to create estimates of the employment that could be generated by a WPA proposed action, as well estimates of employment that are supported by the broader OCS Program. This chapter will also discuss the impacts of the DWH event on the economies of the Gulf of Mexico, as well as the lessons the DWH event has taught us regarding the impacts of oil spills on affected economies. However, given the modest scale of a WPA proposed action relative to the existing OCS Program, the economic impacts of a WPA proposed action are expected to be fairly small.

4.1.1.20.3.1. Description of the Affected Environment

This chapter will present information on the structure of the economies along the Gulf Coast that could be affected by a WPA proposed action. The first section will describe how BOEM defines the areas that could be economically impacted by OCS activities. The first section will also describe 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 WPA proposed action would be most felt. The second section will provide additional information regarding the economic significance of the offshore oil and gas industry in the Gulf of Mexico. The final section will discuss 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 BOEM 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 WPA and CPA. 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 WPA and CPA come from throughout the region. Although the same overall economic impact areas are used to analyze proposed lease sales in the

WPA and CPA, the levels of economic impacts to the different individual EIA's do vary between WPA and CPA proposed lease sales.

The BOEM examines economic impacts over the 40-year life of a WPA 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 WPA proposed action and of the OCS Program; the projected economic impacts of a WPA proposed action are discussed in **Chapter 4.1.1.20.3.2**, while the projected economic impacts of the total OCS Program are discussed in **Chapter 4.1.1.20.3.4**. The methodology BOEM uses to measure employment impacts (and subsequent demographic impacts) over the 40-year life of a WPA proposed lease sale recognizes that most of the employment that results from a WPA 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 **Chapters 4.1.1.20.3.2 and 4.1.1.20.3.4**, 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 WPA proposed lease sale. **Table 4-51** presents the baseline employment projections used to analyze the impacts of a WPA 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 WPA proposed action.

Economics of the Offshore Oil and Gas Industry

The projected economic impacts of a WPA proposed action and of the projected overall OCS Program are discussed in **Chapters 4.1.1.20.3.2 and 4.1.1.20.3.4**. However, this section and the following section will 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, Quest Offshore 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). 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.

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 the 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 4.1.1.16, 4.1.1.17, and 4.1.1.18**. 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 moratorium 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 significant 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 more significant 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 per day in March 2010 to $10,120 per day 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.

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 usual 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 August 2011, the GCCF had paid out approximately $5 billion to affected individuals and businesses. The GCFF had paid out $2 billion in Florida, $1.5 billion in Louisiana, $840 million in Alabama, $380 million in Mississippi, and $120 million in Texas (Gulf Coast Claims Facility, 2011a). 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, it has been affected by permitting delays. Shallow-water drillers' woes are aggravated by the fact that these rigs operate on contracts with oil companies ranging from a few days to a few months. While idle deepwater rigs, which are leased out for years, keep bringing in cash for their owners, shallow-water rigs are in limbo when contracts end.

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 WPA proposed action would be small (<1%), even in light of how the DWH event changed the economic baseline. The expected incremental effects from a WPA proposed action would occur 3-7 years from a WPA 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.

4.1.1.20.3.2. Impacts of Routine Events

Background/Introduction

A WPA proposed action would have economic impacts on a variety of firms along the OCS industry's supply chain. For example, a 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. 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. Given that BOEM's work on MAG-PLAN is ongoing, the employment estimates presented in this section may change between the Draft and Final EIS's. The estimates of the economic impacts of a WPA proposed action are discussed in the next section.

Proposed Action Analysis

The MAG-PLAN's estimates of the employment impacts of a WPA proposed action are presented in **Tables 4-53 through 4-55**. **Table 4-53** presents results for a low-case production scenario, while **Table 4-54** presents results for a high-case production scenario. In **Table 4-53**, we see that a low-case production scenario leads to approximately 10,000 direct jobs, 6,000 indirect jobs, and 29,000 induced jobs in the Gulf of Mexico during the approximately 40-year life-cycle of OCS operations. The majority of these jobs (31,000 jobs) would occur in Texas, primarily in EIA TX-3. About 7,500 jobs would be supported in Louisiana; there would also be employment effects in Florida (2,700 jobs), Alabama (2,300 jobs), and Mississippi (1,700 jobs). **Table 4-53** also shows the levels of employment during the years in which a WPA proposed action would have the largest employment effects in each EIA. The employment effects of a WPA proposed action would peak at slightly more than 1,000 jobs in the Gulf of Mexico under the low-case production scenario. For most EIA's, employment would peak in 2015 or 2018. In **Table 4-54**, we see that the high-case production scenario would lead to 18,000 direct jobs, 11,000 indirect jobs, and 53,000 induced jobs in the Gulf of Mexico. The employment impacts would peak at around 2,000 jobs under the high-case scenario. 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 the firm operating at its existing level as earlier contracts and orders are completed and filled. Thus, these estimates may overestimate the actual magnitude of new employment effects from a WPA proposed action. **Table 4-55** shows the percent of employment during the peak employment years as a percentage of total employment in each EIA. A WPA proposed action, irrespective of whether one analyzes the high-case or low-case scenario, would not cause employment effects >0.1 percent in any EIA along the Gulf Coast.

Summary and Conclusion

Should a WPA 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 WPA proposed action is expected to occur in Texas (primarily in the EIA TX-3) and in the coastal areas of Louisiana. A WPA proposed action, irrespective of whether one analyzes the high-case or low-case production scenario, would not cause employment effects >0.1 percent in any EIA along the Gulf Coast.

4.1.1.20.3.3. 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 4.1.1.16.3, 4.1.1.17.3, and 4.1.1.18.3**. 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 4.1.1.20.1** 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 EIA TX-3) since these are the primary locations were OCS-related employment is concentrated. Plyer and Campanella (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 significant 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.

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 the behavior of the macroeconomy.

Proposed Action Analysis

Figure 3-9 presents data on the probabilities of an oil spill occurring and reaching the coastlines of various counties as a result of a WPA proposed action. **Figure 3-9** presents data on the probabilities of oil reaching certain counties within 10 days and 30 days of an oil spill. The counties that have a 1 percent or greater chance of being impacted by an oil spill within 10 days are Matagorda, Texas (1-2% chance); Brazoria, Texas (1% chance); and Galveston, Texas (1% chance). The counties that have a 1 percent or greater chance of being impacted by an oil spill within 30 days are Matagorda, Texas (2-3% chance); Brazoria, Texas (1-2% chance); Galveston, Texas (1-2% chance); Calhoun, Texas (1-2% chance); Aransas, Texas (1% chance); and Kenedy, Texas (1% chance). 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.

4.1.1.20.3.4 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 will be included with a WPA 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 WPA proposed action would contribute 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. 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. Given that BOEM's work on MAG-PLAN is ongoing, the employment estimates presented in this section may change between the Draft and Final EIS's.

Tables 4-57, 4-58, and 4-59 present employment data using low-case and high-case estimates for OCS activities in the Gulf of Mexico. In **Table 4-59**, we see that the peak employment levels for the entire OCS industry are primarily felt in Louisiana and in Texas (primarily in the EIA TX-3). The greatest overall number of OCS-related jobs will exist in 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, the OCS industry will make up a larger fraction of the economy of south Louisiana. For example, in LA-2, the OCS industry will support 3.3 percent of the total economy during the peak year under the low-production scenario and 5.1 percent of the total economy under the high-production scenario. 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 4.1.1.20.3.2**, a WPA proposed action is expected to contribute 0.1 percent or less to the employment level in each of the EIA's.

Summary and Conclusion

The cumulative impacts of a WPA 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 WPA proposed action are expected have minor impacts to the economies in the coastal Gulf of Mexico.

4.1.1.20.4. 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 accordance with NEPA and the Executive Order, 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; Louisiana, Mississippi, and Alabama jurisdiction over mineral resources extends 3 mi (5 km) from the shore; Texas and the west coast of Florida jurisdiction over the seabed extends out 9 mi (14 km). 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, in preparation) 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.

4.1.1.20.4.1. 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 WPA may rely on onshore facilities within the WPA, the CPA, or both. Onshore activities in support of exploration and production in the WPA (and their environmental consequences) are concentrated around support infrastructure such as ports, canals, heliports, repair yards, pipecoating facilities, and gas processing plants. 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 WPA, the interlinked nature of the offshore industry necessitates a discussion of the CPA 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. 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, and the CPA has six, five of which are located in Louisiana. Most of the counties/parishes with low and medium concentrations are located in Texas (WPA) or Louisiana (CPA).

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, 1984b). 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 and low-income populations. While this allows for a consistent metric for all Gulf Coast States, it is important to keep in mind that Texas's minority population makes up more than half of the State at 54.67 percent.

Environmental justice maps (**Figures 4-26 through 4-35**) display the location of oil-related infrastructure and the distribution of 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, 4 are located in the WPA; of those, and based on the 2010 Census, 2 counties have higher minority percentages than the State average; i.e., there are 67 percent minority residents in Harris County and 55.4 percent minority in Jefferson County. **Figures 4-30 through 4-35** display maps of census tracts within Gulf Coast States overlayed with a map of OCS-related infrastructure. There are 1,036 census tracts within the Texas GOM economic impact area with minority populations greater than 50 percent, and of these, most are concentrated in urban centers like Houston, which is located within Harris County. Harris County also ranks highest in Texas in terms of concentration of OCS-related infrastructure with 10 refineries, 27 petrochemical plants, 95 terminals, and 1 port among other infrastructure types (Eastern Research Group et al., 2007). A BOEM-funded study using the 2000 Census and a weighting scheme to identify counties with heavy concentrations of OCS infrastructure identified clusters of Harris County where 75 percent or more of the population was black. These clusters, however, ran north-south as compared with OCS-related facilities which ran east-west. The opposite can be said for Hispanic clusters. In an area of Harris County where two petrochemical plants, a refinery, and a few small OCS-related facilities appear to be clustered, 75 percent of the population is Hispanic. Jefferson County ranks third highest in terms of concentration of OCS-related infrastructure with 4 refineries, 2 petrochemical plants, 59 terminals, and 2 ports among other infrastructure (Eastern Research Group et al., 2007). According to the Eastern Research Group's study using 2000 Census data, there are several areas where 75 percent or more of the population is black, including a cluster of two refineries and two petrochemical plants. A different situation is seen with the Hispanic population where there are no large areas with more than 50 percent Hispanic (Eastern Research Group et al., 2007).

Thirteen counties/parishes are considered to have a medium concentration (16-49 facilities) of oil-related infrastructure. Of these 13 counties/parishes, 3 are located in the WPA; of those, 2 have higher minority populations than the State average (54.67%), i.e., Nueces County has a 67.12 percent minority population and San Patricio County has a 57.83 percent minority population. This is consistent with South Texas trends, which is 81 percent Hispanic (Texas State Government Homepage, n.d.). Both of these counties also have more people living below the poverty line than the State average. Because these two counties contain the major metropolitan statistical area of Corpus Christi, the size and complexity of the economy and labor force preclude a measurable effect.

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 (USDOC, Census Bureau, 2011). Tract-level household income data from the 2010 Census is not yet available, and this analysis uses the 2009 Community Survey on a county/parish level basis as a placeholder. Only one county, Jefferson County, out of the four WPA high infrastructure concentration counties has a higher poverty rate than its respective State poverty rate, with 19.1 percent of the county living below the poverty line compared with the State's 17.1 percent average. One county, Nueces County, out of the three WPA medium infrastructure counties, had a higher poverty rate than the Texas rate. In the Eastern Research Group's study, which uses census tract data, a smaller level of geographic analysis, they found no apparent visual correlation with percent of the population living below the poverty line and OCS-related facilities within Harris County (Eastern Research Group et al., 2007). Along the Sabine River in Jefferson County, a low-income area was located, which visually correlates with a petrochemical plant, a refinery, and several other types of OCS-related infrastructure.

Baseline Post Hurricanes and Post the *Deepwater Horizon* Event

Whether a proposed lease sale occurs within the WPA or CPA, oil and gas exploration and production activities will rely on an established network of support and processing facilities and associated labor force both within the onshore WPA and CPA. As a result, a baseline change within the CPA could potentially alter the relative risks of a lease sale in the WPA. Therefore, where appropriate, this discussion will consider recent baseline changes in the CPA. In the last 6 years, communities in the Gulf region have sustained three substantial crises—the 2005/2008 hurricane seasons, the recent economic downturn, and the DWH event. The 2008 hurricane season was particularly active for southeast Texas. Hurricane Gustav made landfall mostly in Louisiana, but 71 counties including every southeastern coastal county in Texas was designated for disaster assistance following the storm (*Federal Register*, 2008b). This included the small coastal town of Bridge City in Orange County where nearly the entire town received heavy water damage. On September 13, 2008, Hurricane Ike made landfall over Galveston, Texas, as a large Category 2 hurricane. Ike was the fourth tropical system to strike the Texas Gulf Coast within a 3-year span (USDHS, FEMA, 2008). Harris, Galveston, Chambers, Orange, and Jefferson Counties sustained the most damage from Hurricane Ike. Both Jefferson and Harris Counties are high OCS infrastructure concentration communities, and both counties have higher or equal minority percentages Texas' mean. Sixty percent of the children in the area, however, receive free or reduced-price lunches in school, which is a marker of poverty (USDHS, FEMA, 2008). 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 et al., 2010). This same study found that neighborhoods with higher proportions of minorities also had lower percentages of flood insurance, suggesting that areas like these will generally be slower to recover because of less private recovery resources.

The DWH event in Mississippi Canyon Block 252 has raised several concerns regarding OCS activities and environmental justice. While only few small tarballs (about 35 gallons) were found in Texas on the Crystal Beach of the Bolivar Peninsula, Texas' Gulf Coast communities, it is still unclear whether and how the DWH event might have impacted minority and low-income groups in the WPA (RestoreTheGulf.gov, 2010a). Anecdotal evidence suggests that a loss for Florida, Alabama, Mississippi, and Louisiana's economies may have been a gain for Texas. See **Chapter 4.1.1.18** for a discussion of the tourism and recreation impacts in the WPA.

The Gulf Coast hosts several distinct ethnic, cultural, and low-income groups that rely on the natural resources of the marshes, barrier islands, and coastal beaches and wetlands of the Gulf Coast. This reliance can make these groups particularly vulnerable to the direct and indirect effects of environmental impacts to the area. 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). 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.

Disruptions to the oil and gas industry due to the DWH event and the subsequent deepwater suspension have also raised environmental justice equity concerns. Evidence suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. 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).

Waste Management Related to the *Deepwater Horizon* Event's Waste

The USEPA's standards exempt oil and gas exploration and production wastes from Federal hazardous waste regulations. 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 is 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 determined largely by 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 of the 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 the 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 received, and in what quantities. This table also displays 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 Port Fourchon, Lafourche Parish, Louisiana, and 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 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.

4.1.1.20.4.2. 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 4.1.1.20.4.3**). **Chapter 4.1.1.20.3.1** describes the widespread presence of an extensive OCS support system and the associated labor force, as well as economic factors related to OCS activities. The BOEM estimates that production from a WPA proposed action will be 0.116-0.200 BBO and 0.538-0.938 Tcf of gas, which is a marginal decrease in production from the last WPA proposed action.

Impact-producing factors associated with a WPA 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 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 WPA 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 4.1.1.20.4.4**).

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 4.1.1.20.4.1**, 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 WPA 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. **Figures 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 U.S. Census data 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 4.1.1.20.4.1**, 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 WPA proposed action are not expected to be disproportionate (Eastern Research Group et al., 2007).

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. Oil and gas exploration and production within the WPA help to maintain ancillary industries within the

CPA, including shipbuilding and port facilities. Over one-third (28 facilities) of the U.S. major shipbuilding yards are located on the GOM. Of these, most 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, including 16 OCS-related service bases scattered on the Eastern coast of Texas (The Louis Berger Group, Inc., 2004). The ports of Houston, Corpus Christi, Texas City, Beaumont, and Port Arthur, Texas, are among the busiest in the Nation (Kelley, 2002). Since a WPA proposed action will help to maintain ongoing levels of activity rather than expand them, a WPA proposed action is not expected to 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 regulation, and other State/regional/local regulatory mechanisms. For these reasons, this EIS considers infrastructure projections only for the cumulative analysis (**Chapter 4.1.1.20.4.4)**.

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 most of this goes through Port Fourchon in Lafourche Parish. 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., 2001, p. 21). Port Fourchon has grown in recent decades, in large measure due to its role in servicing the deepwater OCS. The Port recently 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). Additionally, LA Hwy 1 is the only means of hurricane evacuation for thousands of people. Approximately 35,000 people, including 6,000 offshore workers, use LA Hwy 1 for evacuation (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, could grow by as much as 6 percent during the next 10 years (Guo et al., 2001). 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 Bridge 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 will add to an increased risk for users of and residents along the highway. As described in **Chapter 4.1.1.20.4.1,** community string settlement patterns (in this case, on high ground along LA Hwy 1 and Bayou Lafourche) mean that luxury fishing camps and low-income groups would be affected alike 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 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 WPA proposed action would not significantly alter this preexisting situation. Over the last two decades, the area has experienced increased truck traffic and its associated effects due to increasing offshore-related activities at Port Fourchon. Since a WPA proposed action would not significantly alter this preexisting situation, minority and low-income populations would not sustain disproportionate adverse effects from a WPA proposed action.

A WPA 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 for disposal, which lowers the risks to the environment but increases the risk to those people currently 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 4.1.1.20.1 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 WPA proposed action and because of the difficulty of separating 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 WPA proposed action's waste issues as part of the cumulative analysis (**Chapter 4.1.1.20.4.4**).

A WPA proposed action is expected to marginally increase employment opportunities in a wide range of businesses along the Gulf Coast. **Chapter 4.1.1.20.3.2** provides a discussion of employment projections as a result of a WPA proposed action. The BOEM employment projections can neither estimate the socioeconomic or ethnic composition of new employment nor identify the communities in which that employment will 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. One study found that, because of local labor shortages, 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. Because of more recent declines in employment in the oil and gas industry, many communities in southeast Texas have focused on diversification as a strategy to reduce dependency on the industry (Kelley, 2002). Based on BOEM estimates, a WPA proposed action will provide little additional employment growth. Instead, it will 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.

Summary and Conclusion

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a WPA proposed action are expected to be widely distributed and to have little impact. In general, who will be hired and where new infrastructure might be located is impossible to predict, but, in any case, it will be very limited. Impacts related to a WPA proposed action are expected to be economic and to have a limited but positive effect on low-income and minority populations because it will maintain 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 4.1.1.20.4.1**), a WPA proposed action is not expected to have a disproportionate effect on these populations within the WPA.

A WPA proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.1.1.20.4.3. Impacts of Accidental Events

Proposed Action Analysis

Impact-producing factors associated with a WPA 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. Detailed analysis of a high-impact, low-probability catastrophic event such as the DWH event may be found in **Appendix B**. Actions occurring within the WPA may impact environmental justice within the CPA, and vise versa. Facilities located on the coasts of the CPA may provide support for offshore activities on the WPA, and vise versa. Oil and chemical spills on the WPA may be carried by winds and currents to the coasts of the CPA, and vise-versa. As a result, a discussion of a potential accidental event within a WPA proposed action area will address potential impacts of accidental events to environmental justice both in the CPA and the WPA.

Potential oil spills, including surface spills and underwater well blowouts, may be associated with exploration, production, or transportation phases of a WPA proposed action. Detailed risk analysis of offshore oil spills, and coastal spills associated with a WPA 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 WPA 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, 2011e). 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. While not an OCS collision, 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, St. Bernard, and Plaquemines Parish) 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 shutdown 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. Harris County, for example, has clusters of low-income, minority community along the Houston Ship Channel, which is a major conduit for OCS product and would likely receive any captured oil from an accidental event. Additionally, the 2001 Census found that 13.9 percent of Texans spoke English less than "very well" (USDOC, Census Bureau, 2003). In 2005, Texas joined Hawaii, New Mexico, and California as majority-minority states. The fastest growing key segment of the population is Hispanics (Green, 2008). 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, 2011b), has translations in the following languages: Cambodian, Croatian, Spanish, French, Korean, Greek, Laotian, Russian, Thai, and Vietnamese. The Gulf Coast Claims Facility's website and its other resources can be translated into Spanish, Laotian, and Vietnamese, and it also has utilizes 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 WPA 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 affects 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 loss of income from the NMFS fishing closures and drilling suspensions, were partially mitigated by the Gulf Coast Claims Facility 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 Gulf Coast Claims Facility (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.

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 4.1.1.20.4.1,** the Texas Coast was not physically impacted by the DWH event. The primary impacts revolved around consumer perception, which impacted tourism and recreation, and is discussed in greater detail in **Chapter 4.1.1.18**. Texas had the lowest number of submitted claims, with 11,000 awarded claims totaling close to $175 million in payments. The average payout to a Texan claimant within the Gulf of Mexico OCS economic impact areas is a little over $15,000 per claimant. 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. A little over 4,000 claimants claimed to have lost income within Texas because of the DWH event, and claimants were awarded close to $153 million. Several high- or medium-OCS infrastructure counties/parishes of environmental justice concern had high numbers of residents, workers, or both claiming losses. Two high OCS infrastructure counties discussed in **Chapter 4.1.1.20.4.1** had smaller numbers of claimants. In Harris County, 1,163 claimants were awarded close to $83 million; these numbers include both individual claimants and businesses. In Jefferson County, 662 claimants were awarded $14 million.

Chapter 4.1.1.20.4.1 discusses the DWH event 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 contractual relationships between them 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 Gulf Coast Claims Facility (responsible for administrating DWH event claims) indicates that Louisiana's commercial fisherfolks customarily take home approximately 5-15 percent of their total catch for subsistence use (United Louisiana Vietnamese American Fisherfolks, 2010).

As of November 27, 2010, over 29,722 DWH emergency advance payment claims had been filed claiming loss of subsistence use of natural resources. Texas had a total of 301 subsistence claims. 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. What fishers do not sell at the dock, they will save anywhere from 5 to 25 percent of their catch 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 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 dollars. Most claimants received between $0.01 and $5,000. The BOEM is currently funding a subsistence study of the Gulf Coast to better document subsistence distribution networks.

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, nosebleeds, rash, blisters, shortness of breath, and dizziness (Sathiakumar, 2010). Sathiakumar also compiled and reviewed most of the available 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 (NRC, 2005a). The BTEX, the collective name for benzene, toluene, ethylbenzene, and xylenes, are the volatile aromatic compounds often found in discharges and in 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. 1991). 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. Avens et al. found that the magnitude of these data was similar to measurements from ships not involved in oil-slick remediation.

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 us a snapshot of what residents are feeling. 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; 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).

Sathiakumar's (2010) review also found that, in prior post-spill cleanup efforts, the duration of cleaning work was a risk factor for acute toxic symptoms and that seamen had the highest occurrence of toxic symptoms compared with volunteers or paid workers. Therefore, participants in the DWH event's 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. The OSHA released two matrices of gear requirements for onshore and offshore Gulf operations that are organized by task (U.S. Dept. of Labor, OSHA, 2010a). 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, with 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. In 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 et al., 2010). Actual levels of exposure 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).

Summary and Conclusion

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a WPA 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. Many of the long-term impacts of the DWH event to low-income and minority communities are 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. To date, there have been no longitudinal epidemiological 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.

The DWH event was a low-probability, high-impact 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 WPA 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.

4.1.1.20.4.4. Cumulative Impacts

Background/Introduction

Of all activities in the cumulative scenario, those that could potentially impact environmental justice in the WPA 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 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 WPA proposed action may potentially interact within these ongoing external 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 WPA and CPA.

OCS Program

A WPA 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 4.1.1.20.4.2 and 4.1.1.20.4.3**, 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 from a WPA proposed action will be 0.116-0.200 BBO and 0.538-0.938 Tcf of gas (**Table 3-1**). **Chapters 4.1.1.20.1.1 and 4.1.1.20.3.1** describe 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 WPA proposed action or the overall OCS Program may have on any particular community. Future lease sales will 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 (**Chapter 4.1.1.20.1**), that State is likely to experience more employment effects related to a WPA proposed action than are the other coastal states. Because Lafourche Parish, Louisiana, already services about 90 percent of all deepwater oil production 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). While the addition of the C-Port in Galveston, Texas, is expected to increase Texas's share of future effects, Louisiana is likely to continue to experience more than the 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 WPA proposed action will generate 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 WPA 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 approval 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 will not be granted or that appropriate mitigating measures will be enforced by the responsible political entities.

As stated in **Chapter 4.1.1.20.4.1**, 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 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 4.1.1.20.4.1** 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 WPA proposed action to the OCS Program's cumulative environmental justice impacts will be negligible. The analysis also concludes that, overall, OCS programmatic impacts to environmental justice over the next 40 years will likely represent a very small proportion of the cumulative impacts all activities that affect environmental justice.

State Oil and Gas

State oil and gas activity has the potential to adversely impact low-income, minority, and other environmental justice communities either directly or indirectly from onshore activities conducted in support of State oil and gas exploration, development, and production. Louisiana, Mississippi, and Alabama jurisdiction over mineral resources extends 3 nmi (3.5 mi; 5.6 km) from the shore; Texas and the west coast of Florida jurisdiction over the seabed extends out 9 nmi (10.4 mi; 16.7 km). Texas State-owned submerged lands are divided into three areas: the Upper Coast (Brazoria County, north to Orange County); the Middle Coast (Nueces County, north to Matagorda County); and the Lower Coast (Cameron County, north to Kleberg County) (Texas General Land Office, 2011). Texas manages a well-established oil and gas leasing program both onshore and offshore, using the 20- to 25-percent royalties collected from oil and gas production to partially fund the State's Permanent School Fund. The Permanent School Fund provides an equitable level of funding for school districts across the State. 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 will 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.

This is certainly true for Texas, which has historically used oil and gas revenues on State lands to equalize education district disparities across the State.

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 dependant 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, in preparation) 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 National Disease Clusters Alliance, 2011). The underlying causes of a disease cluster can be genetic, environmental, or both. The Natural Resources Defense Council and the National Disease Clusters Alliance identified disease clusters in 13 states; five clusters were identified in Texas, only two of the clusteres fall within the WPA. The five locations in Texas include El Paso in El Paso County, Midlothian in Ellis County, San Antonio in Bexar County, Houston in Harris County, and Corpus Christi in Nueces County. The two clusters located in the WPA (Houston and Nueces) both have higher minority and lower income populations. Researchers from the University of Texas's School of Public Health found that children who live within 2 mi (3 km) of the Houston Ship Channel have a 56 percent greater chance of getting leukemia than children living elsewhere. The elevated rates of childhood leukemia were found in census tracts with the highest benzene and 1,3-butadiene levels in the air. The Houston Ship Channel is the largest petrochemical complex in the United States. The second WPA county with an identified disease cluster is Nueces County where, in 2006, the Texas Dept. of State Health Services found the county had a birth defect rate that was 84 percent higher than the rest of Texas. Researchers were not able to find a direct link between the rates of birth defects and several industrial sites in the county, although they found that mothers living near refineries and old chemical plants had babies with higher rates of life-threatening birth defects of the abdominal wall and diaphragm.

Due to the distance of OCS Program activities offshore, routine events related to a WPA 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 WPA proposed action and 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 1,000 ft^3 (28 m^3) of trash and debris generated per year per manned platform of its 25-year life (Dismukes et al., 2007). A single WPA 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 form 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 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 et al., 2007). **Table 4-61** lists where existing waste sites are located 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 area 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 areas of the 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 4.1.1.4** for a discussion of wetlands in the WPA. As discussed in **Chapter 4.1.1.20.4.1,** tropical storms may be 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 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. According to a USGS 5-year, post-Katrina survey, the 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 the productivity and species diversity associated with Louisiana and Texas wetlands 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 (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 et al., 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, n.d.). 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 nongovernmental organizations efforts 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 the 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, 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). 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. 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. As mentioned earlier, the National Institutes of Health's proposed 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. 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 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 of 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. 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 WPA 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 the (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 will be hired and where new infrastructure might be located is impossible to predict, although a new C-Port in Galveston, Texas, is likely to increase Texas' share of effects. Given the existing distribution of the OCS-related industry and the limited concentrations of minority and low-income peoples, the cumulative OCS Program will not have a disproportionate effect on these populations. Lafourche Parish will experience the most concentrated effects of cumulative impacts. Because the parish is not heavily low-income or minority and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups are not expected to be differentially affected.

To summarize, a WPA 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 WPA 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 will be concentrated in coastal areas and along waterways like Houston's Ship Canal. 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 environmental 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 WPA 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 will be subject to relevant permitting requirements. Coastal landloss/subsidence, hurricanes, and global warming all raise environmental justice issues, as do the lingering 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 will make only minor contributions to these cumulative effects.

4.1.1.21. 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 of Mexico coast (**Table 4-63**). The species within Texas have been designated as endangered, threatened, listed with critical habitat, or proposed threatened. From **Table 4-63**, the following species and the potential impacts, if applicable, have been discussed elsewhere within this EIS: West Indian manatee (**Chapter 4.1.1.11**); green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles (**Chapter 4.1.1.12**); and Attwater's greater prairie-chicken, northern aplomado falcon, piping plover, whooping crane, and mountain plover (**Chapter 4.1.1.14**). The BOEM has only focused on species within coastal counties.

The two mammal species within **Table 4-63** (Gulf Coast jaguarundi and ocelot) are not known to inhabit the coastal areas of Texas and are not discussed elsewhere in this EIS. The Gulf Coast jaguarundi is known to, or is believed to occur in, the southern counties (from Calhoun to Cameron) of Texas (USDOI, FWS, 2011c). These animals are usually found in the dense forest while the lighter-colored individuals are found in more arid and open areas. The ocelot is known to, or is believed to occur in, the southern counties (from Aransas to Cameron) of Texas (USDOI, FWS, 2010c). Fewer than 100 ocelots exist in the United States—in south Texas in the Lower Rio Grande Valley National Wildlife Refuge and Santa Ana National Wildlife Refuge, both near Alamo; in the Laguna Atascosa National Wildlife Refuge near Brownsville; and on a private ranch. The greatest threats to these species are the loss of habitat caused by urban and agricultural development and hunting.

The five plant species listed in **Table 4-63** (i.e., South Texas ambrosia, Texas prairie dawn-flower, Texas ayenia, black lace cactus, and slender rush-pea) are not known to inhabit the coastal areas of Texas and are not discussed elsewhere in this EIS. The South Texas ambrosia historically occurred in Cameron, Jim Wells, Kleberg, and Nueces Counties in south Texas and in the State of Tamaulipas in Mexico. At present, there are six verifiable sites that still contain extant *A. cheiranthifolia* plants, and these are found in scattered, fragmented areas of remaining habitat located in Nueces and Kleberg Counties in the Coastal Bend region of Texas (USDOI, FWS, 2010d). The Texas prairie dawn-flower occurs in Fort Bend, Harris, Lamar, and Trinity Counties, which do not border the Gulf of Mexico. The Texas ayenia has been documented in Cameron, Hidalgo, and Willacy Counties, but it prefers dense, subtropical woodland communities (USDOI, FWS, 2010e). The black lace cactus has been documented in Jim Wells, Kleberg, and Refugio Counties, but it prefers grassy openings on south Texas rangeland invaded by mesquite and other shrubs (USDOI, FWS, 2009e). The slender rush-pea has been documented in Kleberg and Nueces Counties, but it prefers clayey soil of blackland prairies and creek banks in association with short and midgrasses such as buffalograss, Texas wintergrass, and Texas grama (USDOI, FWS, 2008b). The greatest threats to these plant species are the loss of habitat to agricultural and urban development and competition from invasive grasses.

Proposed Action Analysis

Adverse impacts due to routine activities resulting from a WPA 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 WPA 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 the 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 5-8 percent and 8-14 percent probability of contacting Texas State offshore waters based on a WPA proposed action (**Figure 3-9**). State offshore waters of western Louisiana have a <0.5 percent and 1 percent risk based on 10- and 30-day probabilities, respectively, of contact from an OCS spill occurrence resulting from a WPA proposed action. There is a <0.5 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River from a WPA proposed action. The OSRA model projected a spill risk of <0.5 percent for State waters eastward of Louisiana as a result of a WPA proposed action (**Figure 3-9**).

The OSRA modeling results (10- and 30-day probabilities) indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters and contacting coastal GOM counties/parishes due to a WPA proposed action would impact a total of 10 counties/parishes with a >0.5 percent probability (**Figure 3-10**). The Chandeleur Islands have a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action (**Figure 3-25**). The Tortugas Ecological Reserve and Dry Tortugas have a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action. The Florida Keys National Marine Sanctuary has a <0.5 percent risk of impact from an OCS spill occurrence resulting from a WPA proposed action (**Figure 3-25**).

In general terms, coastal waters of the WPA 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 proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters compared with platforms and tankers (**Chapter 3.2.1.5**). Spill estimates for the WPA 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 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 this table because the catastrophic DWH oil spill (4.9 million bbl) 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)**.

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, 2010p). Due to their reliance on terrestrial habitats to carryout their life-history functions at a considerable distance from the GOM, the activities of a WPA proposed action are unlikely to have significant adverse effects on the size and recovery of any of the above mammal and plant species or populations in Texas.

Given that the boundary of the WPA is more than 300 mi (483 km) from the Macondo well and that the westernmost extent of the plume and sheen did not reach the WPA, it appears that the above mammal and plant species would not have been impacted by the DWH event. 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 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 timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, the BOEM subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted methods and approaches. 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). As of November 2011, there are 1,302 active leases in the WPA with ongoing (or the potential for) exploration, drilling, and production activities (USDOI, BOEM, 2011). In addition, non-OCS energy-related activities will continue to occur in the WPA irrespective of a WPA proposed lease sale (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.

Within the WPA, 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 mammal and plant species populations. Therefore, in light of the above analysis on a WPA proposed action and its impacts, the incremental effect of a proposed action on the above mammal and plant species populations is not expected to be significant when compared with historic and current non-OCS-related activities, such as habitat loss and competition.

In any event, the incremental contribution of a WPA proposed action would not be likely to result in a significant incremental impact on the above mammal and plant species within the WPA; in comparison, non-OCS-related activities, such as habitat loss and competition, have historically proved to be of greater threat to the above mammal and plant species.

Summary and Conclusion

Because of the mitigations likely to be implemented in place, routine activities (e.g., operational discharges, noise, and marine debris) related to a WPA proposed action are not expected to have long-term adverse effects on the size and productivity of any 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 WPA 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 WPA proposed action would not be likely to result in a significant incremental impact on the above mammal and plant species within the WPA; 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 conclusion, a WPA proposed action would have no effect on the above-mentioned species. The conclusions for the following species can be found in their respective chapters of this EIS: West Indian manatee (**Chapter 4.1.1.11**); green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles (**Chapter 4.1.1.12**); and Attwater's greater prairie-chicken, northern aplomado falcon, piping plover, whooping crane, and mountain plover (**Chapter 4.1.1.14**).

4.1.2. 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 2.3.1.3.1; Figure 2-1**). All of the assumptions (including the three other potential mitigating measures) and estimates are the same as for the proposed action (Alternative A). A description of Alternative A is presented in **Chapter 2.3.1.1**.

Effects of the Alternative

The following analyses are based on the scenario for a WPA 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 those under a WPA proposed action (**Chapter 4.1**) for the following resources:

- — Air Quality
- — Water Quality
- — Coastal Barrier Beaches and Associated Dunes
- — Wetlands
- — Seagrass Communities
- — Topographic Features
- — *Sargassum* Communities
- — Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities
- — Soft-Bottom Benthic Communities
- — Marine Mammals
- — Sea Turtles
- — Diamondback Terrapins
- — Coastal and Marine Birds
- — 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 WPA 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 WPA proposed action. The potential impact-producing factors to the topographic features of the WPA are anchoring and structure emplacement, drilling-effluent and produced-water discharges, 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 3.**

Impacts of Routine and Accidental Events

All 21 topographic features of the WPA are located within water depths less than 200 m (656 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 WPA, combined with the random nature of spill events, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. **Chapter 4.1.1.6.3** discusses the risk of spills interacting with topographic features, especially the Flower Garden Banks, 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 (in the case of the Flower Garden Banks National Marine Sanctuary) (CSA, 1992a 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 (in the case of the Flower Garden Banks), 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, 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 WPA would be identical to Alternative A. The incremental contribution of a WPA 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, which otherwise would be conducted 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 (in the case of the Flower Garden Banks National Marine Sanctuary); recovery from such an event is anticipated to occur within a period of 2 years.

4.1.3. Alternative C—No Action

Description of the Alternative

Alternative C is equivalent to cancellation of a WPA lease sale scheduled for a specific period in the *Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017*. By canceling a WPA 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 WPA proposed lease sale would be postponed or not occur.

Effects of the Alternative

This Agency published a report that examined previous exploration and development activity scenarios (USDOI, MMS, 2007g). This 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 lease sales contributed to Gulf of Mexico production, while an average WPA lease sale contributed to 3 percent of oil production and 3 percent of gas production in the WPA. In 2006, leases from 15 different lease sales contributed to the installation of production structures in the Gulf of Mexico, while an average WPA lease sale contributed to 6 percent of the installation of production structures in the WPA. In 2006, leases from 70 different lease sales contributed to wells drilled in the Gulf of Mexico, while an average WPA lease sale contributed to 6 percent of wells drilled in the WPA.

As in the past, a WPA proposed 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 WPA proposed lease sale would replace activity resulting from existing leases that have reached, or are near the end of, their economic life.

Environmental Impacts

If a WPA 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 WPA would only be reduced by a small percentage, if any. Therefore, the cancellation of a WPA lease sale would not significantly change the environmental impacts of overall OCS activity. From a programmatic perspective, cancellation of a 5-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 cancellation of a 5-Year Program of lease sales in the Gulf of Mexico, see **Appendix G**.

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.