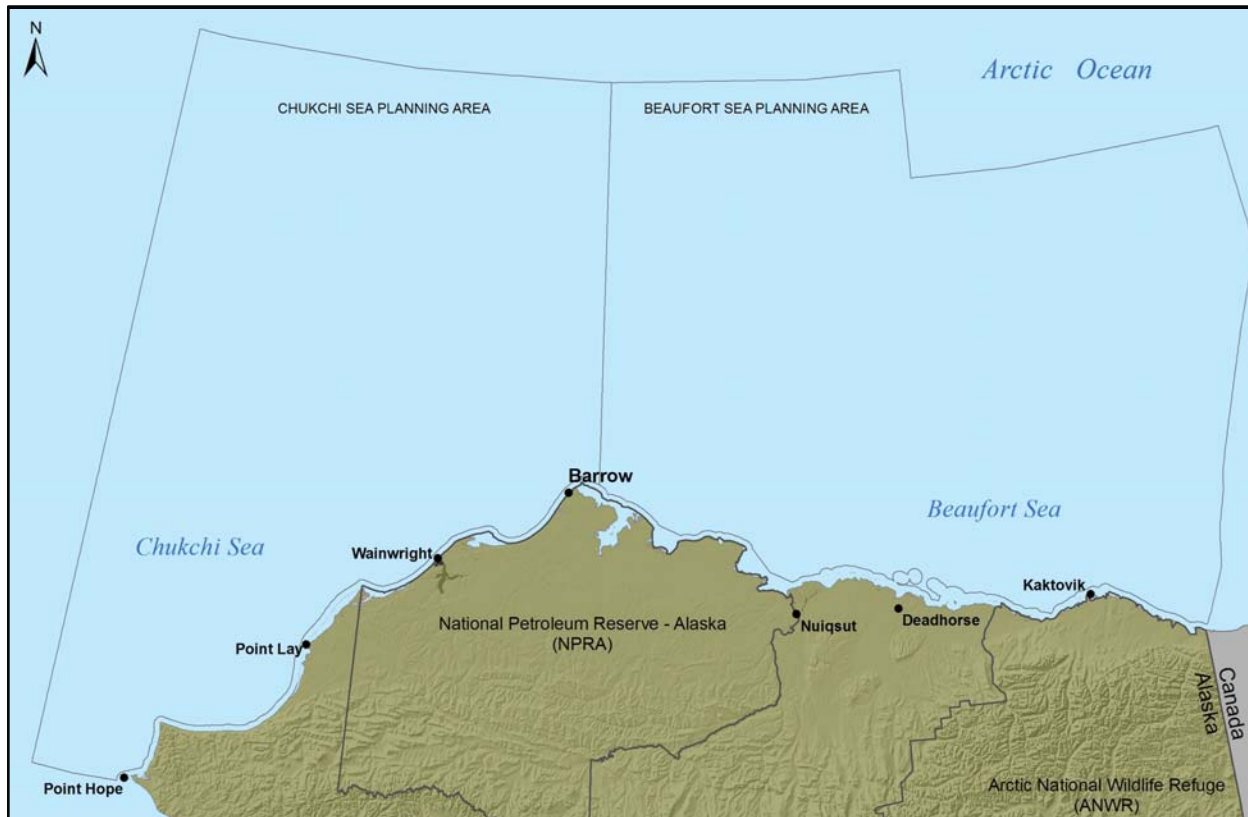


Alaska Outer Continental Shelf



Biological Evaluation for Oil and Gas Activities on the
Beaufort and Chukchi Sea Planning Areas
Prepared for the Fish and Wildlife Service
on
Polar Bear and Polar Bear Critical Habitat, Steller's Eider,
Spectacled Eider and Spectacled Eider Critical Habitat,
Kittlitz's Murrelet, and Yellow-billed Loon



Prepared by the:
Office of Environment
Alaska OCS Region
Bureau of Ocean Energy Management,
Regulation and Enforcement
U.S. Department of the Interior

September 2011

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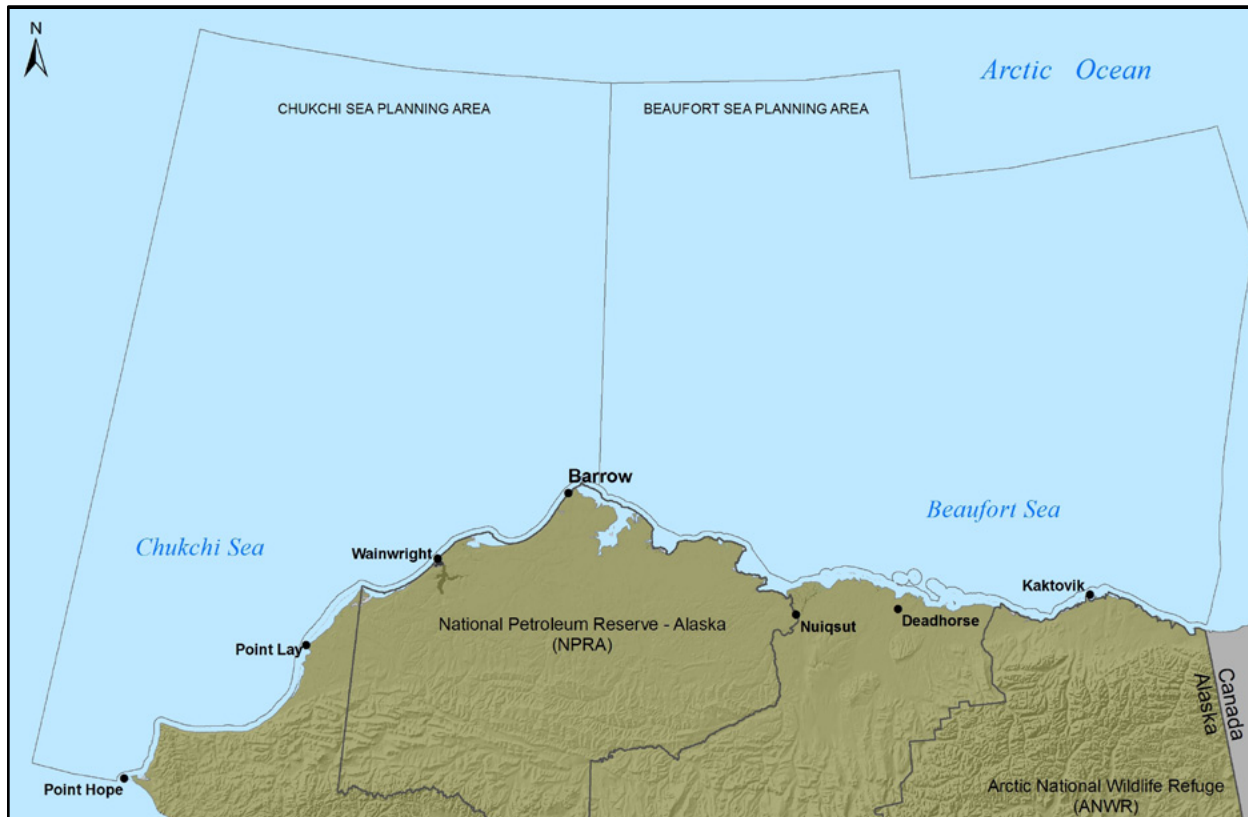
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Polar Bear and Polar Bear Critical Habitat, Steller's Eider
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Prepared by the:
Office of Leasing and Environment
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Regulation and Enforcement
U.S. Department of the Interior

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1. INTRODUCTION

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is responsible for overseeing the safe and environmentally responsible development of traditional and renewable ocean energy and minerals resources on the outer continental shelf (OCS) of the United States in the Chukchi and Beaufort seas of Alaska (often referred to in this document as the Arctic Region) (Figure 1). To this end, the Proposed Action is to continue to authorize oil and gas exploration and development activities in the Arctic Region of the OCS off the northern coast of Alaska, consistent with previous 5-year oil and gas leasing programs. This biological evaluation updates our previous evaluation of 2009 and considers the potential impacts of the proposed action on listed species and designated critical habitats.

Section 7(a)(2) of the ESA requires every Federal agency, in consultation with and with the assistance of the Secretary of the Interior, to ensure that any action it authorizes, funds, or carries out, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. Accordingly, BOEMRE has been working with the U.S. Fish and Wildlife Service (FWS) to ensure that Endangered Species Act (ESA) Section 7 consultations for oil and gas activities the agency authorizes are current, thorough, and as accurate as possible. Since the previous consultations were concluded, new information regarding the types of proposed activities has become available and critical habitat has been established for the polar bear.

Evaluation of the Proposed Action includes potential impacts of reasonable exploration and development scenarios, which include substantial mitigation measures. BOEMRE is preparing this single assessment document to be a thorough and comprehensive analysis of potential impacts to listed species from OCS oil and gas activities in the Beaufort and Chukchi seas, including those resulting from lease sales BF, 124, 144, 186, 195, 202 and 193.

1.1 Background

BOEMRE has responsibility to administer the provisions of the Outer Continental Shelf Lands Act (OCSLA) for the development of oil, gas, and other resources on the United States OCS. In Alaska, this effort has included a number of lease sales in the Beaufort Sea and Chukchi Sea Planning Areas (Figure 1). Table 1 summarizes the number of active leases, their areal extent to the nearest hectare, and their production status by sale and planning area for the Beaufort Sea and Chukchi Sea Planning Areas of the OCS, as of September 6, 2011. At this time, industry holds 487 leases in the Chukchi Sea from Lease Sale 193 held in 2008. In the Beaufort Sea, industry holds 183 leases from previous lease sales dating back to 1979, with the majority of the Beaufort Sea leases issued in sales held in 2005 (Sale 195) and 2007 (Sale 202) (Table 1 and Figure 1). Lessees may relinquish their interest in a lease at any time during the term of the lease.

Table 1. Summary of active leases in the Beaufort and Chukchi seas.

Sale-Planning Area	Hectares	Active Leases	Production/Development
BF -Beaufort Sea	3,033	2	Northstar
124-Beaufort Sea	2,235	1	Northstar
144-Beaufort Sea	3,334	2	Liberty
186-Beaufort Sea	21,311	7	none
195-Beaufort Sea	170,464	82	none
202-Beaufort Sea	196,276	89	none
193-Chukchi Sea	1,116,277	487	none
Total	1,512,930	670	

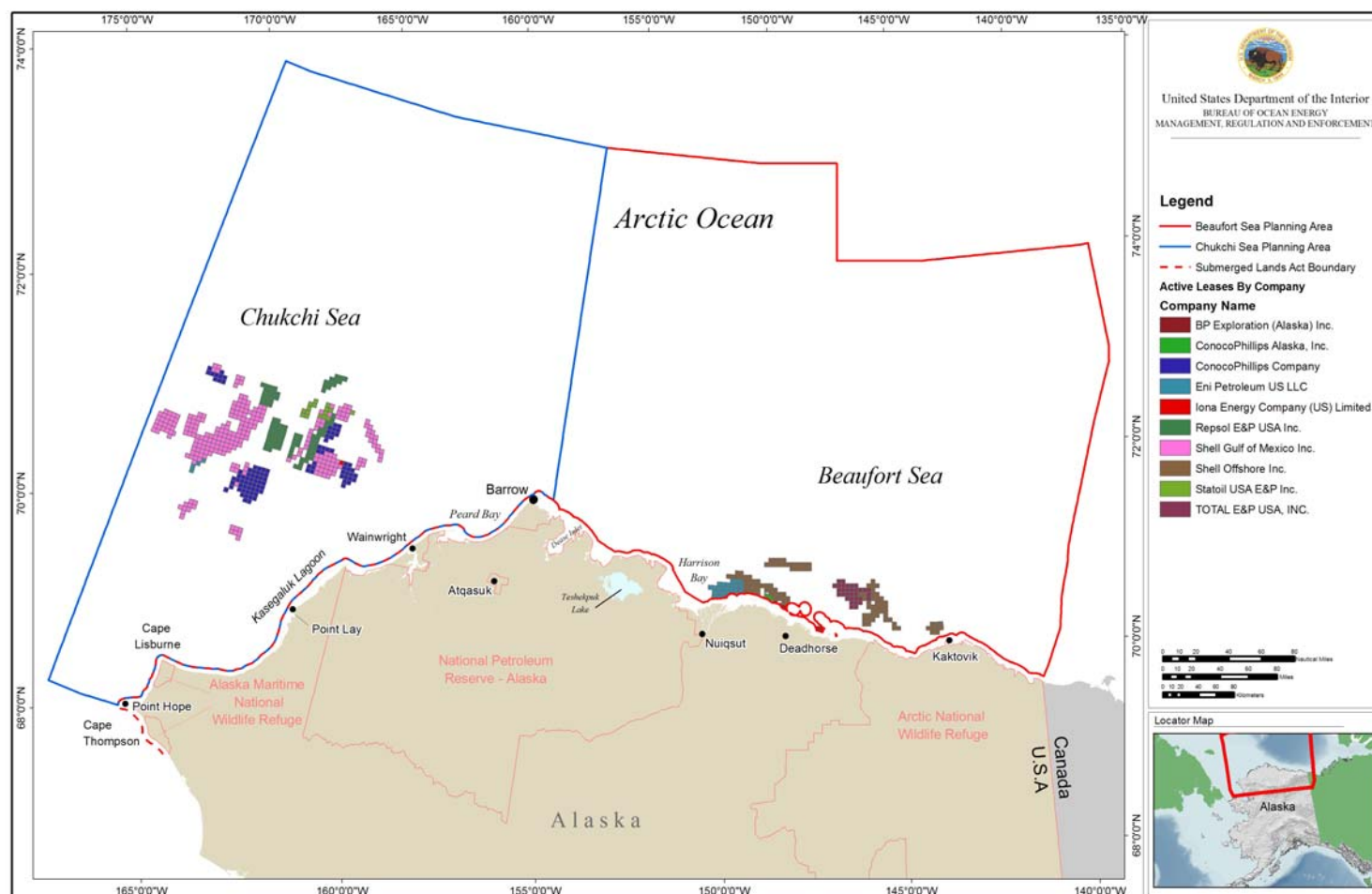


Figure 1. Active leases in the Chukchi Sea and Beaufort Sea Planning Areas (September 1, 2011).

The Northstar Production unit has been producing oil since 2001 and comprises three BP Exploration (Alaska), Inc. leases in the Beaufort Sea OCS (Table 1). Northstar is a joint unit under Federal and State of Alaska regulatory authority. Total production between 2001 and June 2010 was nearly 145 million barrels, with the Federal portion totaling approximately 26 million barrels. The Liberty project is in the early development phase (pending construction) and comprises two BP Alaska Inc. leases.

The OCSLA sets out a four-stage process for planning, leasing, exploration, development and production of oil and gas resources in the OCS. The OCSLA review process gives the Secretary of the Interior a “continuing opportunity for making informed adjustments” in developing offshore energy resources in order to ensure all activities are conducted in an environmentally sound manner.

Section 7 consultation is not conducted at the first OCSLA stage (development of a 5-Year leasing program). Regulations at 50 CFR 402.14(k) allow incremental consultation on part of the entire action as long as that part does not violate Section 7(a)(2), that there is a reasonable likelihood that the entire action will not violate Section 7(a)(2), and that the agency continues consultation with respect to the entire action. BOEMRE specifically requests incremental Section 7 consultation, with leasing and exploration considered and authorized in the first step. Thus, at the leasing and exploration stages, BOEMRE consults on the early lease and exploration activities (seismic surveying, ancillary activities, and exploration drilling) to ensure that neither pre-lease nor post-lease activities will result in jeopardy to a listed species or cause adverse modification of designated critical habitat. However, as required, the consultation also considers potential impacts through the endpoint of the actions as described in the hypothetical development and production scenarios for each planning area. This comprehensive analysis considers the potential direct and indirect effects of the Proposed Action, as well as cumulative effects, when added to the environmental baseline, to listed species. Any proposed development and production would require further consultation with FWS.

BOEMRE and the FWS have previously consulted on activities that may affect threatened species: the polar bear (*Ursus maritimus*), Steller’s eider (*Polysticta stelleri*), and spectacled eider (*Somateria fischeri*). BOEMRE and FWS have conferenced on activities that may affect candidate species: the Kittlitz’s murrelet (*Brachyramphus brevirostris*) and yellow-billed loon (*Gavia adamsii*). The FWS determined that leasing and exploration activities, and the hypothetical development and production activities that may result from lease sales, would not jeopardize the continued existence of listed species. This document supersedes our previous consultation document (USDOI, FWS, 2009) and includes newly designated critical habitat for the polar bear. This document also updates the description of the proposed action to include new technologies that have been proposed for use since 2009.

2. PROPOSED ACTION

2.1 Action Area

The action area consists of the OCS in the Chukchi Sea and Beaufort Sea and immediately adjacent areas, including State waters between the planning areas and the Alaska coastline (Figure 1). The action area is divided into two planning areas, one in the Beaufort Sea and the other in the Chukchi Sea.

2.2 The Proposed Action

The proposed action is to authorize oil and gas leasing, exploration, and development and production activities on the OCS of the Chukchi and Beaufort seas consistent with previous 5-year oil and gas leasing programs. The proposed action consists of one scenario for each planning area. Exploration and development activities are specific to each scenario. The primary purpose of the scenario is to provide a common basis for analysis of potential environmental impacts associated with future activities. The scenarios differ between the two planning areas due to differences in existing infrastructure, geology, oceanography and biological differences between the two seas.

The scenarios were developed by BOEMRE and are based on professional knowledge of industry processes and limitations. The interrelationships between geology, engineering, and economics must be reasonable. Accordingly, in the two scenarios, BOEMRE assumes a reasonable scale of exploration and development that considers petroleum potential, available technologies, and industry trends. The scenarios are generalized because the size and specific locations of future commercial accumulations are unknown at the present time.

Components of the scenarios are described as either reasonably foreseeable or speculative. A reasonably foreseeable component is interpreted here to mean a continuation of current trends into the near-term future, or approximately 10 years. The hypothetical scenarios are more likely to be accurate within this shorter timeframe. Beyond 10 years, there is a decrease in the availability and reliability of information used to make estimates within the scenario. Consequently, components that estimate activities or actions beyond 10 years are necessarily more speculative. Speculative components may involve a substantial change from historical trends and are less certain.

2.2.1 Exploration and Development

The OCS in the Beaufort and Chukchi seas is considered a frontier area in terms of oil and gas exploration and development and production activities. The pace of exploration in frontier areas is typically slow, with years between drilling activities.

It is logical to assume that when companies buy leases, they will try to explore those leases, and exploration activities are therefore considered to be reasonably foreseeable. A lease block is 2304 hectares or approximately 9 square miles. Primary lease terms are typically 10 years, so exploration activities would take place within this timeframe. Exploration activities include marine seismic surveys, ancillary activities, and well drilling, all of which have occurred for several decades in the Arctic region, so the characteristics of these activities are well known. Deep penetration seismic surveys are expected both on and off lease, as companies may want to acquire seismic data over larger areas that are not currently under lease in order to better understand the underlying geology. BOEMRE also assumes that although some discoveries would be made, not all discoveries would be commercially viable. If a potentially economically viable prospect is confirmed during exploration drilling activities, deep penetration seismic activity levels are expected to increase above existing levels of activity, but would not exceed the maximum levels analyzed in the scenarios.

In contrast to exploration, development and production activities are more speculative. A few facilities are located near shore in the Beaufort Sea and none have been constructed in the Chukchi Sea. Widespread development in these OCS areas would be a substantial change from historical

trends which have involved exploration, but only three OCS development projects (Endicott, Northstar and Oooguruk) over the past 30 years. Several of the largest geologic prospects have been drilled, with nine wells being determined producible (30 CFR 250.115), but without making commercial discoveries. Although these expansive areas are barely tested (35 wells have been drilled in the two planning areas), the challenges that have hindered past operations are likely to affect future operations as well. The high petroleum resource potential in the Beaufort Sea and Chukchi Sea planning areas undoubtedly will continue to attract industry interest in leasing and exploration. However, development and production will not occur unless numerous factors (e.g., industry funding, engineering feasibility, regulatory requirements, and litigation) that could easily delay or eliminate the development and production of a promising discovery can be overcome.

Further, discovering a producible reservoir is just the beginning of a lengthy regulatory process with progressively higher expenditures for industry. Development scenarios herein assume that the largest discoveries would be developed first. Company standards for a commercially viable project may preclude development; in other words, marginally economical or difficult projects would not be developed. Speaking to this point, only one (Northstar) of six discoveries in the Beaufort Sea OCS has been developed to date.

The most recently published petroleum assessment (USDOI, BOEMRE, 2011) estimated that these two planning areas could hold mean technically recoverable oil resources of 23.6 billion barrels (Bbbl) (88% of the entire Alaska OCS) and mean technically recoverable gas resources of 104.4 trillion cubic feet (Tcf) (80% of the entire Alaska OCS). The term “undiscovered, technically recoverable resources” focuses on geologic attributes. The resource potential is estimated without being constrained by economic considerations, such as the existence of transportation infrastructure to take the resources to market. The only constraint is that conventional recovery techniques are assumed. Resources are undiscovered oil and gas accumulations that have not been located and, when discovered, may not be feasible to develop as commercial fields. In contrast, *reserves* are proven oil and gas accumulations that are feasible to produce with a profit acceptable to the field operator. Typically, a large portion of the technically recoverable petroleum potential could occur in accumulations that are too small, too hard to identify, or too costly to develop. This portion of the resource potential would be unlikely to become producing reserves because companies would not develop uneconomical projects. It also is unlikely that industry would attempt to drill all of the accumulations mapped in an area, because this would require hundreds of wells and the cost would be prohibitive. A more realistic scenario is that industry would identify the “biggest and best” prospects and drill them first. If these discoveries can be commercially developed, they would become infrastructure hubs around which smaller and/or commercially riskier fields could be developed later. The development history of the North Slope is a good example of this typical development trend (biggest-first) in a frontier area.

Exploration activity is a logical continuation of historical trends in these frontier areas. The scale of future activities will depend on many factors, the most critical of which are the physical challenges of the Arctic environment (extreme seasonal conditions); technology advancements to operate safely in a difficult, new setting; regulatory requirements (access to prime exploration areas); industry funding (acquiring leases, exploration, and drilling); and commodity prices (to support high-cost activities). In fact, most blocks in the lease-sale areas probably would experience little or no activity. Since 1979, 10 OCS oil and gas lease sales have been held for the Beaufort Sea. Only a small fraction of the blocks offered (15,353 blocks) were leased by industry (929 leases, or 6% of the blocks offered). Even fewer of the leases were tested by exploratory drilling. Thirty exploration wells in the Beaufort OCS tested 20 prospects (26 leases). Nine of the wells were deemed producible, meaning capable of flowing hydrocarbons for two hours after flow stabilizes (30 CFR 250.115) and were classified as discoveries (capable of producing in paying quantities). Only one of the producible discoveries has been developed (Northstar). Therefore, widespread development activities would not occur unless cost, logistics, and environmental challenges are minimized or overcome and/or technology is

improved. The obvious conclusion is that leasing levels are a poor indication of later commercial development.

As a result of nearly 30 years of leasing and exploration activities, four production facilities, Endicott, Northstar, Oooguruk, and Nikaitchuq have been installed offshore in the Alaskan Beaufort Sea, all located in state waters. The State Endicott field was the first offshore facility. It is two miles (mi) offshore in State waters with artificial gravel production islands that are connected to shore by a causeway. Endicott began production in 1986. The Federal/State Northstar field became the second offshore facility and started production in 2001. Northstar is a joint Federal/State of Alaska unit. Total production from 2001 through July 2011 is approximately 150.8 million barrels, with the Federal portion at about 26.9 million barrels. The State Oooguruk field began producing in July of 2008 and is producing oil from an artificial gravel island located three mi offshore in five feet (ft) of water. The State Nikaichuq field began producing in February 2011 from an artificial gravel island. The development plan for the Federal Liberty field involved ultra long-reach wells (5-8 mi) drilled from the Endicott satellite drilling island.

The history of industry activities in the Chukchi Sea is somewhat different than the Beaufort Sea, in that the Chukchi Sea OCS has experienced fewer lease sales than the Beaufort Sea OCS (three sales in the Chukchi Sea; 10 sales in the Beaufort Sea) and fewer exploration wells have been drilled (five wells in Chukchi Sea; 30 in Beaufort Sea). These first exploration wells tested some of the largest mapped prospects in the area without making an announced discovery. All of these leases were relinquished by industry and there were no active leases in the Chukchi Sea for over 10 years. Lease Sale 193 was held in 2008, but the sale remains under litigation. The Chukchi Sea scenario assumes the Sale 193 leases remain valid. Industry leased 487 tracts in Lease Sale 193—many of which covered the same prospects that were leased in previous sales. With advances in marine seismic data acquisition, drilling and development technologies, and much higher oil prices, industry is likely to re-evaluate some of these prospects. However, with the high costs of exploration wells (perhaps \$50 million per well), companies will be very selective about the prospects they drill. Industry probably will focus their exploration on the largest prospects, because large volumes have the best chance of commercial success. The first stand-alone field in the Chukchi Sea would have to contain 1 Bbbl (or more) to proceed with economically viable development because there is no existing oil and gas infrastructure. The 2006 assessment indicated that 13 oil accumulations of this size (or larger) could be present (USDOl, MMS, 2006). Some discoveries in the Chukchi Sea may not be economical to develop, whereas similar-size discoveries in the Beaufort Sea might be developed because they are closer to existing infrastructure and oil could be recovered at a lower cost. The scenarios presented here are not likely to influence industry decisions. For purposes of this analysis, BOEMRE assumes that an oil pipeline (TAPS in its present form or a future redesigned pipeline) will continue to carry oil from fields in northern Alaska, including the OCS.

2.2.2 Natural Gas Development

It is reasonable to assume that offshore gas production will not occur without a system to transport natural gas to market. For decades, the associated gas produced from North Slope oil fields has been used as fuel in facilities or injected back into reservoirs to enhance oil recovery. This situation is expected to continue for at least another decade (until 2020) for existing North Slope fields because no gas transportation project has been approved. There are approximately 35 Tcf of known gas resources that could be produced when a transportation system is operational. These proven resources would be recovered before the estimated 200 Tcf of undiscovered gas resources throughout northern Alaska and in the offshore areas (Houseknecht and Bird, 2005). The construction of a major gas transportation project would be very costly (over \$30 billion), and no firm project has overcome the many economic challenges. Nonetheless, recent efforts to promote a gas pipeline project by the State of Alaska and Federal Government could spur renewed industry interest in gas-related exploration activities.

Three underlying facts should be considered in any gas development scenario:

- There is no transportation system at the present time to deliver natural gas from northern Alaska to market. The abundant gas resources (known and undiscovered) in this region will continue to be stranded until a large capacity gas transportation system is operational.
- A large-diameter, overland gas pipeline system is the most feasible and economically viable project to move large quantities of gas from Arctic Alaska to outside markets. Several pipeline projects have been proposed by industry and strongly supported by federal and state governments, although none have been constructed. Other gas transportation strategies (e.g. LNG) have more difficult technical, regulatory and economic challenges than an overland gas pipeline project.
- The economics of gas development are much less attractive than oil development. The main disadvantage is caused by a price discount for gas on an energy-basis compared to oil, whereas development costs for new gas fields (platforms, wells and pipelines) are similar to oil fields. This unfavorable cost-price relationship burdens all gas projects.

Although oil development is more likely to occur before gas development because there is an existing transportation system (TAPS), an assumption is made in the scenario that a gas pipeline would be constructed to carry future gas production to market by 2020. After reviewing different gas-transportation strategies, BOEMRE concluded that a large overland pipeline system is a more feasible and more likely alternative than liquefied natural gas export by tankers or other marine transportation strategies. A gas pipeline that begins operating in 2020 could be used by new OCS gas fields, because it would take at least 10 years to discover and develop fields in the Beaufort Sea and/or Chukchi Sea. Although BOEMRE acknowledge that other alternative gas-transportation strategies are possible, it is impractical to attempt to analyze all of the possibilities. Our scenario assumes a gas pipeline system from the North Slope to southern markets because it has the most favorable engineering, economics, and political support.

2.2.3 Sequence of Activities

There is a progression or sequence of events that occurs during OCS oil and gas development as companies seek to locate and develop hydrocarbon deposits. This progression will determine how many concurrent activities could occur annually and will vary by year and by the success of the previous activity. The following is a summary of the progression.

The first step is to search for hydrocarbon deposits. This is accomplished using deep penetration seismic surveying techniques. Companies conduct two-dimensional (2D) or three-dimensional (3D) geophysical seismic surveys to identify areas of interest. Two-dimensional seismic surveying techniques are used to provide broad-scale information over a relatively large area. The results of these surveys may indicate potential hydrocarbon accumulations. Companies can invest in these surveys either in advance of a lease sale (to help determine their bidding or other decisions) or on speculation to sell to other companies.

Once companies have identified potential prospects that could contain hydrocarbon accumulations, they submit bids for leases in a lease sale, where exploration and development rights are conveyed. The competitive lease sale awards lease blocks to highest qualified bidders following a fair market value review by BOEMRE. Past lease sales in the Beaufort Sea and Chukchi Sea have resulted in a mosaic of lease ownership clustered over possible prospects (Fig. 1). After obtaining a lease, companies may conduct additional deep penetration seismic surveys and may also add controlled source electromagnetic (CSEM) studies to further define prospects and select proposed drilling locations.

Prior to drilling a well, companies are required to conduct high-resolution geophysical surveys (also called “site clearance or shallow hazards surveys”) to further evaluate the near-surface geology, to locate shallow hazards, to identify depth to seafloor (bathymetry), potential shallow faults or gas

zones, depth and distribution of ice gouges in the seabed, to obtain engineering data for drilling or placement of structures (platforms and pipelines), and detect archaeological resources and certain types of benthic communities. These surveys may be collected over part of an individual lease block (about 3mi x 3mi) or several contiguous lease blocks. Site clearance surveys are generally conducted on selected potential drill sites in order to verify suitability. Several contiguous or separate blocks can be cleared during one survey, and typically more blocks are surveyed/cleared than the number of wells eventually drilled. These ancillary surveys would typically need to be completed at least one season in advance of a drilling operation. Companies may also use these techniques to survey off lease marine areas for possible subsea pipeline routes or related purposes.

Based on the evaluation of deep penetration seismic and ancillary activity data, a company could propose to drill several test wells in the area of interest. The type of drilling rig used depends on water depth, sea-ice conditions, ice-resistance of the rigs, and unit availability.

2.2.4 Description of Activities

The following sections describe anticipated OCS activities and are organized according to the different phases of petroleum activities. First, exploration activities (deep penetration seismic surveys, ancillary surveys and other related activities, and exploration drilling) are discussed, followed by development and production.

Most activities and infrastructure associated with oil production are very similar to those associated with gas production. For instance, seismic surveys and exploration wells are used to discover either type of field; the same type of platform is likely to be used for development; production wells would be drilled by the same equipment; and subsea pipeline installation also would be very similar (probably trenched offshore).

2.2.4.1 Exploration

Exploration operations consist of (1) deep penetration seismic surveys to evaluate geologic formations and locate potential hydrocarbon prospects, (2) ancillary seismic and geophysical surveys to provide a hazard clearance assessment prior to drilling and optimize drilling sites, and (3) exploration drilling activities to delineate and evaluate hydrocarbon reservoirs. These operations typically require some form of additional support, such as crew change vessels, refueling, etc. In addition to the activities discussed here, and as a part of the proposed action for the 2009 biological evaluation, in-ice seismic surveys (using an icebreaker to conduct seismic operations in newly forming ice) are a part of the proposed action for this biological evaluation. For each activity, the following subsections will identify typical support vessels and other equipment. Two exploration scenarios are then discussed—one for the Beaufort Sea and one for the Chukchi Sea. These scenarios include anticipated levels of activity.

Table 2. Maximum anticipated annual level of exploration activities on the OCS of the Chukchi and Beaufort seas.

Sea	Deep Penetration Survey/CSEM	Ancillary Seismic & Other Activities	Drilling Ships/Rigs/Units
Beaufort Sea	5	4	2
Chukchi Sea	5	4	2

Note: CSEM= Controlled Source Electromagnetic Survey

The current BOEMRE scenarios include a maximum anticipated level of activity (see Table 2). However, it is not appropriate to assume that this peak level of activity will occur over the entire 10 years of the lease terms. The history of OCS oil and gas exploration in the Arctic Region has shown that these peak levels of activity occur during the early to middle part of lease terms, and it is unlikely that all of the categories will be at the peak number during any one year.

BOEMRE does not have regulatory authority to require permit holders to cooperate in data collection activities. There are, however, abundant reasons that compel industry operators to cooperate on obtaining and sharing geologic and geophysical data in the Arctic. These reasons include cost savings, regulatory complexity, and difficulty of acquiring data (e.g., short acquisition season, weather and ice conditions). The collaboration between two or more leaseholders could effectively reduce the number of these operations. It is not reasonable to assume that many of these activities are happening at the same place or time.

Deep Penetration Surveys

Deep penetration exploration surveys have been conducted in OCS regions of the Chukchi Sea and Beaufort Sea and are likely to continue. This section describes types of 3D and 2D “deep penetration” seismic surveys (ancillary “shallow hazard” surveys and other related activities are described in the next section). Each type of typical deep penetration activity and its associated vessels and equipment is also listed in Table 3 (below).

Seismic exploration is the search for commercially and economically valuable subsurface accumulations of crude oil, natural gas, and minerals by the recording, processing, and interpretation of reflected seismic waves from the substrates by introducing controlled source energy (such as seismic air gun impulses, and vibratory waves) into the earth. Seismic sound is typically generated in marine environments by air guns that fire highly compressed air pulses into the water that transmit seismic sound waves into the subsurface rock layers. Seismic waves reflect and refract off subsurface rock formations and travel back to acoustic receivers called hydrophones. The characteristics of the reflected seismic waves (such as travel time and intensities) are used to locate subsurface geologic formations that may contain hydrocarbon deposits and to help facilitate the location of prospective drilling targets.

Table 3. Summary of activities support vessels and equipment for deep penetration operations.

Marine Deep Penetration Surveys	
Activity	Support Operations
Deep Penetration Towed-Streamer 2D/3D Surveys	1 source/receiver vessel 1 support vessel 1 possible monitoring vessel
Ocean-Bottom-Cable Seismic Surveys 2 vessels for cable layout/pickup	1 recording vessel 1 or 2 source vessel(s) 1 or 2 small support vessels
In-Ice Towed-Streamer 2D Surveys	1 source/receiver vessel 1 icebreaker 1 possible icebreaker support vessel
On-Ice (Hardwater, Over Ice) 2D/3D Surveys	1 recording vehicle 1-2 crew transport vehicles Varying numbers of vibroseis (thumper) vehicles 1 bulldozer
Controlled Source Electromagnetic Survey	1 source vessel

Survey operations could be conducted during each year, with individual surveys focusing on a different prospect or area. Future marine (open-water and in-ice) deep penetration seismic surveys could occur during the Arctic summer and early winter (July-December), depending on ice conditions in the proposed survey areas. Open-water seismic surveys in the Beaufort Sea OCS would probably be coordinated with surveys in the Chukchi Sea OCS and could employ the same vessels. Ancillary activities are likely to occur during the open water July-November time frame. “On-ice”, “hardwater” or “over-ice” surveys using vibroseis methods could occur during winter (January-May), nearshore in the Beaufort Sea.

Deep Penetration Towed-Streamer 3D and 2D Surveys

Seismic data are collected over a specific area using a grid pattern. These data are analyzed and a framework of the subsea geology is constructed to assist with locating potential hydrocarbon

accumulations. Marine deep penetration towed-streamer 3D seismic surveys vary markedly depending on client specifications, subsurface geology, water depth, and target reservoir(s). Individual survey parameters may vary from the descriptions presented here. The vessels conducting these surveys generally are 70-120 meters (m) long. Vessels tow one to three source arrays, of six to nine guns each, depending on the survey design specifications required for the geologic target. Most operations use a single-source vessel. However, more than one source vessel will be used in wide or rich azimuth surveys or when using smaller vessels, which can not provide a large enough platform for the total seismic gun array necessary to obtain target depth. The overall sound output for the permitted activity will be the same, but the firing of the source arrays on the individual vessels will be alternated.

The source array is triggered approximately every 10-15 seconds, depending on vessel speed and the desired penetration depth. The timing between shots varies and is determined by the spacing required to meet the geological objectives of the survey; typical spacing is either 25 or 37.5 m, but may vary depending on the design and objectives of the survey. Airguns can be fired between 20 and 70 times per km. Modern marine-seismic vessels tow up to 20 streamers with an equipment-tow width of up to approximately 1,500 m between outermost streamers. Streamers may be greater than 8 km (5 mi) in length. Biodegradable liquid paraffin, kerosene, and solid/gel are materials used to fill the streamer and provide buoyancy.

Three-dimensional survey data are acquired along pre-plotted tracklines within a specific survey area. Adjacent tracklines for a 3D survey generally are spaced several hundred meters apart and are parallel to each other across the survey area. The areal extent of the equipment limits both the turning speed and the area a vessel covers. It is, therefore, common practice to acquire data using an offset racetrack pattern, whereby the next acquisition line is several km away from and traversed in the opposite direction of the track line just completed. A vessel may conduct seismic surveys day and night, for days, weeks, or months, depending on the size of the survey and data-acquisition capabilities of the vessel. Vessel operation time includes not only data collection, but also deployment and retrieval of gear, line turns between survey lines, equipment repair, and other planned or unplanned operations. Seismic survey data collection is often shut-down by sea state or weather conditions and mechanical or other operational reasons. Vessel transit speeds typically range from 8-12 kn (12.8-19.3 km/hour) depending on a number of factors including, but not limited to, the vessel itself, sea state, and ice conditions. Marine 3D surveys are acquired at vessel speeds of approximately 4.5 kn (8.3 km/hour).

The 2D and 3D surveys use similar survey methods but different operational configurations. Three dimensional survey lines are spaced closer together and are concentrated in a specific area of interest. These surveys provide the resolution needed for detailed geological evaluation. A 2D survey provides less-detailed geological information because the survey lines are spaced farther apart. These surveys are used to cover wider areas to map geologic structures on a regional scale. Two-dimensional seismic survey vessels generally are smaller than 3D survey vessels, although larger 3D survey vessels are able to conduct 2D surveys. The source array typically consists of three or more sub-arrays of six to eight airgun sources each, but may vary as newer technology is developed. Typically, one streamer is towed during 2D operations. Figure 2 illustrates a typical marine seismic survey using streamers.

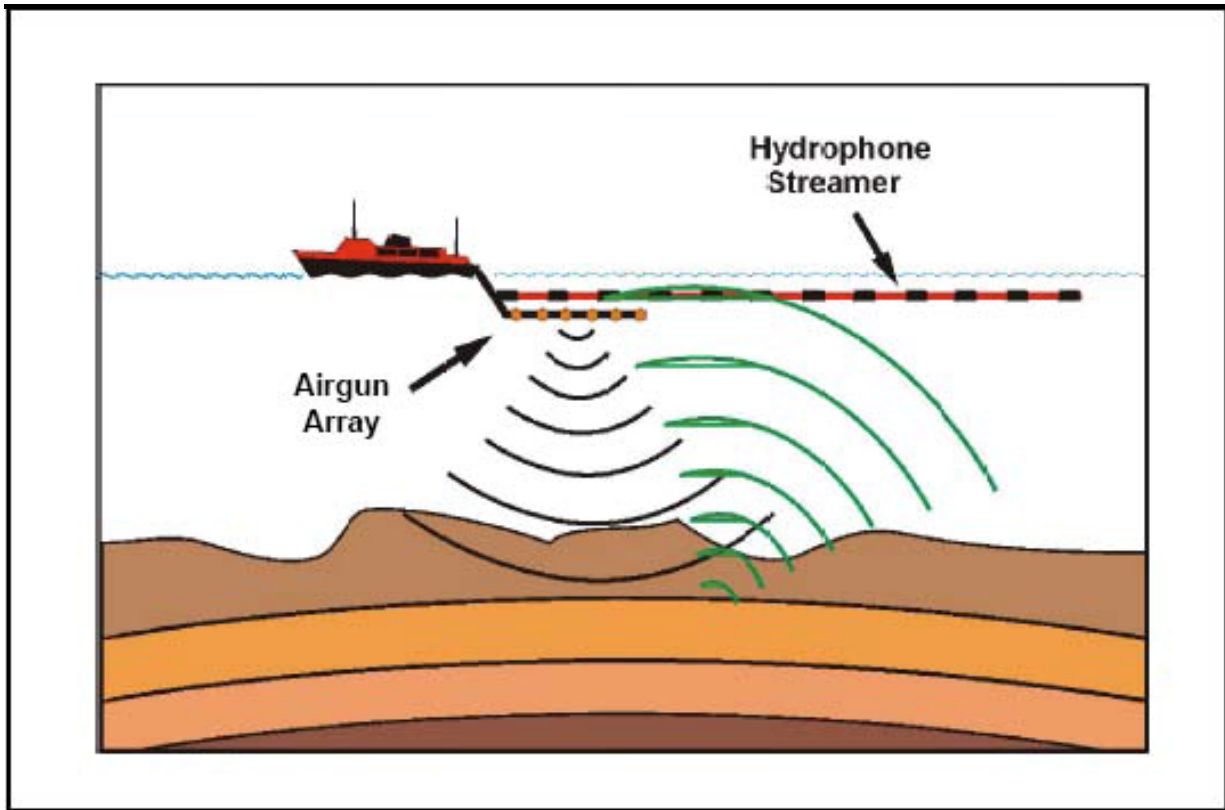


Figure 2. Simple illustration of a marine seismic survey (2D or 3D) operation using streamers (USDOL, BOEMRE, Alaska OCS Region).

Seismic vessels acquiring 2D data are able to acquire data at four to five knots, 24 hours a day, and collect between 85-110 line-miles (137 to 177 line-km) per day, depending on the distance between line changes, weather conditions, and downtime for equipment problems. Typically, a survey vessel can collect 5,000-8,000 line-miles (8,047 to 12,875 line-km) during an open water seismic operational season in Arctic waters.

At least one support vessel would be used for safety considerations, general support, maintenance, and resupply of the main vessel, but it would not be directly involved with the collection of seismic data. Crew changes, refueling, and resupply for the seismic vessels are generally on a four to six week schedule. Helicopters, when available, may be used for vessel support and crew changes. An additional support vessel may be used to monitor for marine mammals ahead of the survey vessel. Additional fixed-wing aircraft may also be employed to monitor marine mammals.

Ocean-Bottom Receiver Seismic Surveys

Ocean-bottom Cable Seismic Surveys

Ocean-bottom cable (OBC) seismic surveys are used in Alaska primarily to acquire seismic data in transition zones where water is too shallow for a towed marine streamer seismic survey vessel and too deep to have grounded ice in the winter. The OBC seismic survey requires the use of multiple vessels. A typical survey includes: (a) two vessels for cable layout/pickup; (b) one vessel for recording; (c) one or two source vessels; and (d) possibly one or two smaller utility boats.

Most operations use a single source vessel, but multiple source vessels may be used if size prohibits loading the full airgun array required for the survey on one vessel. The overall sound output for the permitted activity would be the same for a two vessel shoot, as the source arrays alternate vessels when firing. These vessels are generally, but not necessarily, smaller than those used in towed-streamer operations. OBC seismic arrays are frequently smaller in size than the towed marine

streamer arrays due to the shallower water depths in which OBC surveys are usually conducted. The utility boats can be small, in the range of 10-15 m (33-49 ft).

An OBC operation begins by laying cables off the back of the layout boat. Cable length typically is 4-6 km (2.5-3.7 mi) but can be up to 12 km (7.5 mi). Groups of dual component (2C) or multiple component (4C) seismic-survey receivers (a combination of both hydrophones and vertical-motion geophones) are attached to the cable in intervals of 12-50 m (39-164 ft). Multiple cables are laid on the seafloor parallel to each other using this layout method, with a cable spacing of between hundreds of meters to several kilometers, depending on the geophysical objective of the seismic survey. When the cable is in place, a vessel towing the source array passes over the cables with the source being activated every 25 m (82 ft). The source array may be a single or dual array of multiple airguns, which is similar to the 3D marine seismic survey. Figure 2.2 illustrates an OBC operation.

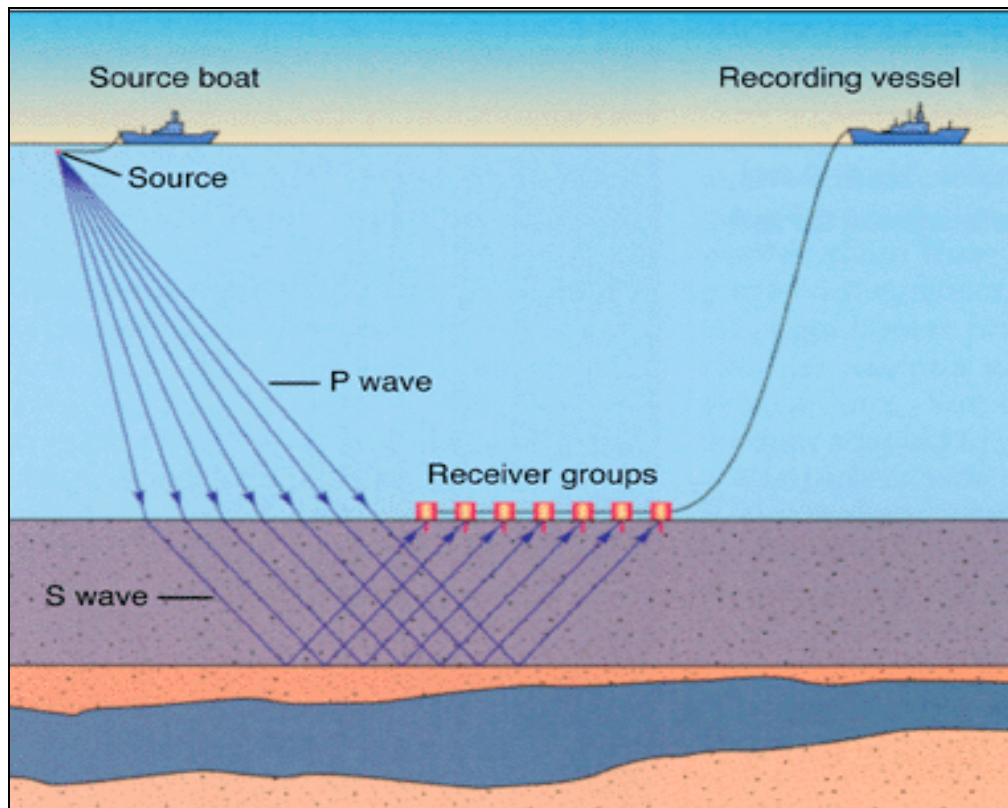


Figure 3. Illustration of Ocean Bottom Cable survey (Schlumberger, 2011).

After a survey line is completed, the source ship takes about 10-15 minutes to turn around and pass over the next cable. When a cable is no longer needed to record seismic survey data, it is recovered by the cable-pickup ship and moved to the next recording position. A particular cable can lay on the seafloor anywhere from two hours to several days, depending on operation conditions. Normally, a cable is left in place for about 24 hours.

An OBC seismic survey typically covers a smaller area (approximately 16 by 32 km [10 by 20 mi]) and may spend days in an area. In contrast, 3D towed-streamer seismic surveys cover a much larger area (thousands of square miles) and stay in a particular area for hours. While OBC seismic surveys could occur in the nearshore shallow waters of the Beaufort Sea, they are not anticipated to occur in the Chukchi Sea OCS because of its greater water depths and the exclusion of the near shore OCS area from leasing. Recent technological developments have been introduced that provide improved operational flexibility for equipment deployment, recovery, and data collection in the field, but the costs are high compared to streamer-collected data.

Ocean-bottom Node Seismic Surveys

Ocean-bottom Node (OBN) surveys, like the OBC surveys presented above, place receivers on the seafloor instead of towing them behind a survey vessel. Seafloor seismometers, precursors to modern day nodes, have been used in the academic community for crustal exploration for more than 70 years (Fisher 2004). However, the seismographs typically used to conduct these studies are not the best choice for exploration/production seismic operations as they do not have the required precision (Ronen et al. 2007). In the late 1990s, SeaBird Geophysical developed the first commercially available OBN system, specifically tailored to the oil and gas industry (Durham, 2010).

The OBNs used in oil and gas operations are four component (4C) receivers that include three orthogonal geophones and one hydrophone, capable of measuring both shear (S) and compressional (P) waves, which cannot be done using 2C cables or towed streamers. The nodes are typically deployed in groupings called patches, using Remotely Operated Vehicles in deep water and ropes/cables in shallower water. The geologic target depth determines the node spacing and size of the patch. Generally, node spacing ranges between 50 m and 500 m (164 ft and 1,640 ft). If enough nodes are available, large patches (160 – 250 km²) are collected as a single survey. However, a larger area can also be surveyed using smaller patches (10 – 30 km²) with fewer nodes, which are combined to complete the entire survey (Ray et al., 2004; Beaudoin and Ross, 2007; Chopra, 2007; Duey, 2007). An Ultra Short Baseline system (which measures the distance and bearing from a transceiver mounted on a survey vessel to an acoustic transponder at the node and combines these data with GPS, vessel heading and attitude) is commonly used to calculate the node position.

To utilize the 4C nodes to their fullest capabilities, survey lines are not only run directly above the nodes in the patch. Additional lines can be run at distances offset from the patch (at least 3 km to 20 km [1.9 mi to 12.4 mi]) to provide wide-azimuth data. If lines are run in several different directions, multi-azimuth data can also be collected. The distance between airgun shots is typically 50 m (164 ft) (Beaudoin and Ross, 2007; Smit et al., 2008; Smit, 2010; Vázquez García, et al., 2005).

Node technology has been used in the deepwater Gulf of Mexico in areas with abundant infrastructure to image below salt (Smit et al., 2008; Baudoin, 2010) and to perform 4D surveys (Reasnor, et al., 2010; Smit, 2010). Nodes have also been used to image offshore fields internationally in: Mexico (Vázquez García, 2005); Angola (Lecerf, et al., 2010); Nigeria (Subsea World, 2009); and West of the Shetland Islands (Oil Voice, 2010).

In Alaska, OBNs in conjunction with land based nodes have been successfully tested in Cook Inlet to evaluate the technology's capability to image the transition zone, between shallow water and land, for oil and gas exploration (Fairfieldnodal, 2011). These nearshore/transition zone surveys typically require two source vessels, up to three node deployment vessels, and a separate mitigation vessel. While this technology has only been used in Cook Inlet so far, it is easily transferrable to the Beaufort or Chukchi Sea.

This technology has the potential to: improve imagery associated with complicated oil and gas fields; clarify lithology and predict fluids in reservoir rocks; increase oil recovery; and decrease development risks (Enovation Resources, 2011). It is reasonable to project that nodes could be used in the Arctic during the life of this EIS.

In-Ice Seismic Surveys

A change in technology has allowed geophysical (seismic reflection and refraction) surveys to be conducted in sea-ice concentrations of up to 10/10s new ice. Sea-ice concentration is defined in terms of percent coverage in tenths. An area with 1/10 coverage of ice means the area contains ice floes that cover 1/10th of the visible area, with 9/10s being open water; whereas, 10/10 coverage of ice means there is no open water in the area. This new technology uses a seismic source vessel and an icebreaker. The icebreaker generally operates ~0.5–1 km (~0.3–0.62 miles [mi]) ahead of the seismic acquisition vessel, which follows at speeds ranging from 4 to 5 kn (7.4 to 9.3 km/hour). Seismic

vessels cannot stop while streamers are deployed, so in-ice seismic surveys are only technologically feasible in ice thin enough to allow for continuous forward progress by the icebreaker and the seismic vessel. Like open-water 2D/3D surveys, in-ice surveys operate 24 hours a day or as conditions permit. A third vessel may be used for one or more support trips as conditions allow during the length of the survey.

The seismic airgun arrays and streamers used in-ice are similar to those used in open water marine surveys. A single hydrophone streamer, which uses a solid fill material to produce constant and consistent streamer buoyancy, is towed behind the vessel. The streamer receives the reflected signals from the subsurface and transfers the data to an on-board processing system. The survey vessel has limited maneuverability while towing the streamer and thus requires a 10 km (6.2 mi) run-in for the start of a seismic line, and a 4-5 km (2.5-3.1 mi) run-out at the end of the line.

On-Ice (Hardwater, Over Ice) 2D/3D Surveys

Winter vibroseis seismic operations use truck-mounted vibrators that systematically put variable frequency vibrations through the ice and into the seafloor. At least 1.2 m of sea ice is required to support heavy vehicles used to transport equipment offshore for exploration activities. These ice conditions vary, but generally exist from sometime in January until sometime in May in the Arctic. The exploration techniques are most commonly used on landfast ice, but they can be used in areas of stable offshore pack ice near shore. Several vehicles are normally associated with a typical vibroseis operation (Table 3). One or two vehicles with survey crews move ahead of the operation and mark the source receiver points. Bulldozers are occasionally needed to build snow ramps to smooth rough offshore ice within the survey area. This methodology is limited to the Beaufort Sea near shore. The Chukchi Sea polynya system is nearshore and does not allow for stable near shore fast ice conditions for this methodology.

With the vibroseis technique, activity on the surveyed seismic line begins with the placement of geophones (receivers). All geophones are connected to the recording vehicle by multi-pair cable sections. The vibrators move to the beginning of the line and recording begins. The vibrators move along a source line, which is at some distance or angle to a receiver line. The vibrators begin vibrating in synchrony via a simultaneous radio signal to all vehicles.

In a typical survey, each vibrator will vibrate four times for 4-30 sec at each location. The entire formation of vibrators subsequently moves forward to the next energy input point (e.g., approximately 67 m in most applications) and repeats the process. Most energy is beamed downward. In a typical 16- to 18-hour day, a survey will complete 6 to 16 linear km in 2D seismic surveys, and 24 to 64 linear km in a 3D seismic survey.

Controlled Source Electromagnetic Survey

Measurements of electrical resistivity beneath the seafloor have been used in oil and gas exploration, but historically have been collected through the wire-logging of wells. Since 2002, several electromagnetic methods have been developed for mapping sub-seafloor resistivity, including marine controlled source electromagnetic (CSEM) sounding (Eidesmo et al., 2002). The CSEM introduces electrical currents into the earth and measures the resistivity of the seafloor substrate. This method uses a mobile horizontal electric dipole source and an array of seafloor electric receivers (Figure 4). The length of the dipole varies between 10-50 m and the system is towed at approximately 24-40 m above the seafloor at a speed of 1-2 kn. The transmitting dipole emits a low frequency (typically 0.5 to 10 Hz) electromagnetic signal into the water column and into the underlying sediments. Subsurface attenuation of the electromagnetic field depends on the subsurface resistivity and frequency of the source signal (Hesthammer et al., 2010). Electromagnetic energy is attenuated in the conductive sediments, but in higher resistive layers (such as hydrocarbon-filled reservoirs), the energy is less attenuated. This contrast is what is detected to provide data on potential areas of interest. With better resolution of the subsurface structure using 3D seismic data, well locations could be proposed. Prior

to drilling exploration wells, electromagnetic surveys may be conducted over potential prospects to reduce exploration risk.

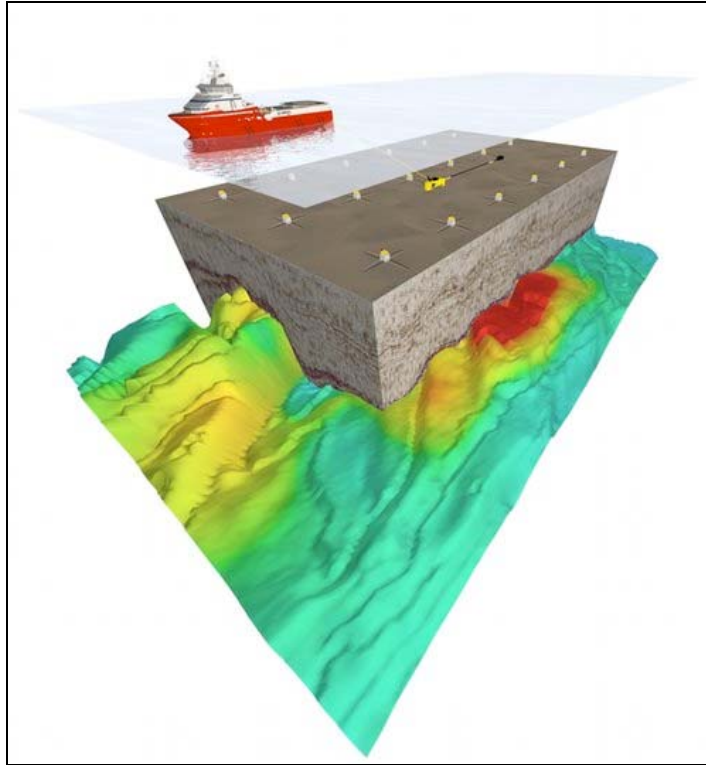


Figure 4. Schematic view of a Controlled Source Electromagnetic Survey. A horizontal electric dipole is towed above receivers that are deployed on the seafloor (Electromagnetic Geoservices ASA, 2010).

Gravity and Gradiometry Surveys

Gravity surveys have been used for years in the oil and gas industry. Measurements taken at the Earth's surface express the acceleration of gravity of the total mass of the Earth. State of the art gravity meters can sense differences in the acceleration (pull) of gravity to one part in one billion. Because of their high sensitivity, these instruments can detect mass variations in the crustal geology, possible indicators of fault displacement and geologic structures favorable to hydrocarbon production.

In 1994, the U.S. Defense Department declassified the 3D full tensor gradiometer. This allowed the gravity field gradient to be determined by using accelerometers to measure the spatial multi-components of gravity. The equipment utilized for gradiometry surveys is much more complex than that of traditional gravity surveys. The new gravity data are evaluated in three dimensions instead of the two dimensions in traditional gravity surveys and can better define subsurface bodies of varying densities.

The increase in data resolution provided by the new technology has allowed the geology below salt to successfully be imaged in the Gulf of Mexico. This technology could be used in the Arctic Seas as a method for identifying features such as basins and edges, but would not replace 3D seismic.

Vertical seismic profiling

Vertical seismic profiling (VSP) is conducted once some drilling has been completed. These programs use hydrophones suspended in the well at intervals which receive signals from external sound sources, usually an airgun(s) is suspended from the drill rig or a nearby supply vessel. Data are used to aid in determining the structure of a particular petroleum-bearing zone. Purely defined, VSP refers to measurements made in a vertical wellbore using geophones inside the wellbore and a source at the surface near the well. In the more general context, VSPs vary in the well configuration, the

number and location of sources and geophones, and how they are deployed. Most VSPs use a surface seismic source, which is commonly a vibrator on land and an air gun in offshore or marine environments. In addition to tying well data to seismic data, the vertical seismic profile also enables converting seismic data to zero-phase data and distinguishing primary reflections from multiples (per the Schlumberger Oil Field Glossary: www.glossary.oilfield.slb.com/).

Ancillary Activities

Ancillary activities are those necessary oil and gas activities conducted by a leaseholder on BOEMRE-issued leases for the purposes of obtaining data and information for their Exploration Plan (EP) or Development and Production Plan (DPP) (30 CFR 250). The regulations at 30 CFR 250.209 state that ancillary activities must comply with the performance standards listed in 30 CFR 250.202(d) and (e); the regulations at 30 CFR 250.202(d) and (e) state that proposed activities shall be conducted in a manner that does not unreasonably interfere with other uses of the OCS and does not cause undue or serious harm to the human environment. Lessee and operators must provide a written notification to BOEMRE 30 calendar days in advance of and receive authorization from BOEMRE before commencing ancillary activities.

This section describes the various ancillary activities-related techniques likely used by operators in OCS regions of the Beaufort Sea and Chukchi Sea (Table 4, below). This includes high-resolution

Table 4. Summary of ancillary activities and support operations.

Ancillary Activities	
Activity	Support Operations
High-resolution surveys including airguns	1 source/receiver vessel 1 possible monitoring vessel
High-resolution surveys using only sonar	1 source vessel
Vibroseis	Truck mounted vibrators over ice Support rollogons, snow machines—number dependent upon the size of the operation.
Electromagnetic surveys	1 survey vessel

geophysical and site-clearance data that are collected as required to support a permit to drill. The site clearance data are used to locate shallow hazards, obtain engineering data for drilling or placement of structures (platforms and pipelines), and detect archaeological resources and certain types of benthic communities. The descriptions below are not intended to be a comprehensive analysis of all techniques; instead, BOEMRE provides fundamental details of the typical techniques and methods used. Particular attention is paid to seismic techniques and especially the role of seismic sources (e.g., airguns), as seismic sources were identified during the scoping process as an environmental concern.

Ancillary activities (30 CFR 250.207)

- geological and geophysical (G&G) exploration and development activities: G&G explorations are surveys on a lease that use seismic reflection, seismic refraction, magnetic, electromagnetic, gravity, gas sniffers, coring, or other systems to detect or imply the presence of oil, gas, or sulphur in commercial quantities. Development G&G activities means those G&G and related data-gathering activities on a lease conducted after the discovery of oil, gas, or sulphur in paying quantities.
- geological and high-resolution geophysical, geotechnical, archaeological, biological, physical oceanographic, meteorological, socioeconomic, or other surveys; or
- studies that model potential oil and hazardous substance spills, drilling muds and cutting discharges, projected air emissions, or potential hydrogen sulfide releases.

Below BOEMRE separates high resolution shallow hazards and site clearance surveys from other ancillary activities for discussion.

High Resolution Shallow Hazards and Site Clearance Surveys

Prior to submitting an exploration or development plan, oil and gas industry operators are required to evaluate any potential geological hazards and document any potential cultural resources or benthic communities pursuant to 30 CFR 250. BOEMRE, Alaska Region, has provided guidelines (Notices to Lessees 05-A01, 05-A02, and 05-A03) that require high-resolution shallow hazards surveys to ensure safe conduct and operations in the OCS at drill sites and along pipeline corridors, unless the operator can demonstrate there is enough previously collected data of good quality to evaluate the site. These data are vital not only when planning for the design and construction of a facility, but also to ensure that all associated activities are completed safely.

Shallow-hazards and site-clearance surveys use various geophysical methods (e.g., seafloor imaging, water-depth measurements, and high-resolution seismic reflection profiling) designed to identify and map hazards and may also collect oceanographic data. Most basic components of a geophysical system include a sound source to emit acoustic impulses or pressure waves, a hydrophone or receiver that receives and interprets the acoustic signal, and a recorder/processor that documents the data.

The suite of equipment used during a typical shallow hazards survey consists of single beam and multibeam echosounders which provide water depths and seafloor morphology, side scan sonar that provides acoustic images of the seafloor, and seismic systems which produce sound waves that penetrate the seafloor. The waves will reflect at the boundary between two layers with different acoustic impedances, producing a cross sectional image. These data are interpreted to infer geologic history of the area. Seismic energy can be produced by different types of sources: a sub-bottom profiler, which provides 20-200 m sub-seafloor penetration with a 6 to 20 cm resolution; a bubble pulser or boomer with 40-600 m sub-seafloor penetration; and a multichannel seismic system with 1,000-2000 m sub-seafloor penetration. Magnetometers that detect ferrous items have not been required in the Alaska OCS to date. One vessel is used for shallow hazard and site clearance surveys. In some cases there may be 1–2 support vessels.

- **Echo sounders** measure the time it takes for sound to travel from a transducer, to the seafloor, and back to a receiver. The travel time is converted to a depth value by multiplying it by the sound velocity of the water column. Echo sounders generally are mounted to the ship's hull or on a side-mounted pole. Single beam echosounders measure the distance of a vertical beam below the transducer. The frequency of individual single beam echosounders can range from 3.5 to 1000 kHz with source levels between 192 to 205 dB re 1 μ Pa at 1 m (rms) (Koomans, 2009). Multibeam echosounders emit a swath of sound to both sides of the transducer with frequencies between 180 and 500 kHz and source levels between 216 and 242 dB re 1 μ Pa at 1 m (rms) (Hammerstad, 2005; HydroSurveys, 2010).
- **Side-scan sonar** is a sideward-looking, narrow-beam instrument that emits a sound pulse and "listens" for its return. The side scan sonar can be a two or multichannel system with single frequency monotonic or multiple frequency Compressed High Intensity Radar Pulse (CHIRP) sonar acoustic signals. The frequency of individual side scan sonars can range from 100 to 1600 kHz with source levels between 194 and 249 dB re 1 μ Pa at 1 m (rms). Pulse lengths will vary with according to the specific system, monotonic systems range between 0.125 and 200 milliseconds (ms) and CHIRP systems range between 400 and 20,000 ms. (HydroSurveys, 2008a; Dorst, 2010). A 2D image results in a detailed representation of the seafloor and any features or objects on it. The sonar can be either hull mounted or towed behind the vessel.
- **Very high-resolution seismic reflection profilers** including subbottom profilers and boomers or bubble pulsers consist of an electromechanical transducer that sends a sound pulse down to the seafloor. (Greene and Moore, 1995). Sparkers discharge an electrical pulse in seawater to generate an acoustic pulse. The energy reflects back from the shallow

geological layers to a receiver on the subbottom profiler or a small single channel streamer. Subbottom profilers are usually hull mounted or pole-mounted; the other systems are towed behind the survey vessel. These systems range in frequency from 0.2 to 200 kHz, with source levels between 200 and 250 dB re 1 μ Pa at 1 m (rms) (Laban et al., 2009).

- **The multichannel seismic system** consists of an acoustic source which may be a single small gun (air, water, GI, etc.) 10 to 65 in³ or an array of small guns usually two or four 10 in³ guns. The source array is towed about 3 meters behind the vessel with a firing interval of approximately 12.5 m (7-8 s). A single 300-600 m, 12-48 channel streamer with a 12.5 m hydrophone spacing and tail buoy is the passive receiver for the reflected seismic waves. A 40 in³ airgun array is commonly used in the Arctic as the source for these multichannel seismic surveys. This array will typically have frequency between 0 and 200 Hz and a source level between 196 and 217 dB re 1 μ Pa at 1 m (rms) (USDOC, NMFS, 2008, 2009, 2010). Water gun arrays may occasionally be used to conduct high resolution surveys. The guns create sound energy by inducing cavitation through shooting water from a cylinder. Compared to airguns of similar size, water guns produce more energy above 200 Hz (Greene and Moore, 1995).

Survey ships are designed to reduce vessel noise because the higher frequencies used in high-resolution work are easily masked by the vessel noise if special attention is not paid to keeping the ships quiet. Surveys are site specific and can cover less than one lease block, but the survey extent is determined by the number of potential drill sites in an area. The typical survey vessel travels at 3-4.5 kn (5.6-8.3 km/hour). A single vertical well site survey will collect about 70 line-miles of data per site and take approximately 24 hours. BOEMRE regulations require data to be gathered on a 150- by 300-m grid within 600 m of the drill site, a 300 by 600 m grid out to 1200 m from the drill site, and a 1,200 by 1,200 m grid out to 2,400 m from the well site. If there is a high probability of encountering archeological resources, the 150- by 300-m grid must extend to 1,200 m from the drill site.

Other Ancillary Activities

In addition to those ancillary activities required to evaluate geological hazards and provide site clearance, there are other ancillary activities that can provide more detailed information about a prospective site. These are important for understanding such site characteristics as sediment structures, strudel scouring, ice gouges, and a variety of shallow hazard information.

- **Natural field electromagnetic surveys** do not induce electrical currents into the earth, but instead, a receiver detects the natural electrical and magnetic fields present in the earth.
- **Geological/geochemical surveys** involve collecting bottom samples to obtain physical and chemical data on surface sediments. Sediment samples typically are collected using a gravity/piston corer, grab sampler, or dredge sampler. Shallow coring, using conventional rotary drilling from a boat or drilling barge, is another method used to collect physical and chemical data on near-surface sediments.
- **Strudel Scour Surveys** are conducted in the spring. A helicopter is used to locate holes in the ice below which scouring is likely to occur. Scouring occurs where water flows under ice and disturbs the sea floor bottom, at stream mouths for example. After the ice has retreated, a survey vessel collects side scan sonar and echosounder data to map the scouring. Pipelines would not be placed in areas subject to scouring.
- **Ice gouge surveys** generally use echosounders and sidescan sonars to map tracks created by icebergs and multi year ice when their keels drag along the seafloor. These furrows can be very deep and may remain visible for years, or even decades. Any pipe laid must be deeper than the deepest ice gouges.

- **Shallow hazard surveys** along a proposed pipeline corridor are addressed in NTL 05-A02 Shallow Hazards Survey and Evaluation for Alaska Outer Continental Shelf (OCS) Pipeline Routes and Rights-of-Way. Geophysical equipment used for these surveys includes, echosounders, side scan sonar, subbottom profilers, seafloor sampling and soil boring equipment. A magnetometer would be required if it is likely to find a shipwreck or other ferrous debris along the route.

Drilling

After deep penetration surveys have identified potential prospects, exploration drilling is needed to discover and appraise the hydrocarbon reservoir. A single drilling rig could drill one to four wells per year, which could include dry wells, discovery wells and delineation/appraisal wells. Drilling operations are expected to take between 30-90 days for each well, depending on the depth to the target formation, downhole difficulties during drilling, and logging/testing operations. Several wells could be drilled in one area in order to delineate a single prospect or a single drill rig could be moved during the season to explore a different prospect site. Geologic mapping indicates that the prospects in the Arctic OCS that are most likely to be drilled have reservoir depths ranging from 3,000-15,000 ft in the subsurface. For purposes of this analysis, BOEMRE estimates that a typical exploration well would be 10,000 ft.

During exploration drilling, operations could be supported by either helicopters and supply vessels or both. Helicopters could fly from coastal-area base camps at a probable frequency of one to three flights per day. Support-vessel traffic would likely be one to three trips per week. An example of the various activities, vessels, and equipment that could be associated with exploratory drilling is given in Table 5. The actual number of associated vessels and aircraft would depend upon the exact location of the drill site, the distance from a shore side base camp or port, and the plan that the individual oil company proposes.

It is expected that authorized on-site waste discharges from drilling operations would be 100% of the rock cuttings and 20% of the drilling mud (80% of the drilling mud is reconditioned/reused). For a typical exploration well, the on-site discharges would be 95 tons of mud per well (475 tons total with 20% waste) and 600 tons of rock cuttings. These estimates are in dry weight with 1 ton = 2,000 pounds.

Table 5. Summary of drilling activities and support operations.

Drilling Activities	
Activity	Support Operations
Drilling from an artificial island	1 support vessel for crew changes/supplies 1 tug/barge for major resupply (production) Daily, periodic helicopter transport
Drilling using a steel-drilling caisson	Modified very large crude carrier vessel (SDC) 2-3 tugs during transport/positioning 1 support vessel for crew changes, resupply trips Daily, periodic helicopter transport
Exploratory Drilling from a Drillship	1 or 2 icebreakers 1 anchor handler 1 or 2 oil spill response barge and tug 1 tank vessel for spill storage 1-3 oil spill response vessels (OSRV) 2-4 [small] support vessels
Exploratory Drilling from a Jackup rig	1 or 2 icebreakers 1 or 2 oil spill response barge and tug 1 tank vessel for spill storage 2-4 [small] support vessels

Different types of drilling mud could be used in well operations and each would have a different composition. The type of drilling mud used depends on its availability, the geologic conditions, and the preferences of the drilling contractor. Several different types of drilling mud are commonly used

to drill a well, and most (80%) of these substances are recycled. BOEMRE assumes that the drilling mud discharged as a waste product (20% of the total) would be a water-based mud. A typical composition of drilling mud (EPA Type 2, Lignosulfonate Mud) that potentially could be discharged at an exploration well site is described on page IV-12 of the Lease Sale 193 EIS (USDOJ, MMS, 2007). The more expensive synthetic drilling fluids are generally reconditioned and not discharged, but all fluid discharges are regulated by the EPA and Alaska State DNR to avoid adverse environmental consequences. The amount of cuttings and the area of sea floor that might be exposed would depend upon the depth of the well and the current in that area. Generally, drilling cuttings fall out over an area of a few acres. As an example, Shell Gulf of Mexico, Inc. has estimated that between 4100 and 4152 bbls of cuttings would be discharged at drill sites in the Chukchi Sea.

Beaufort Sea Scenario

As of August 1, 2011, there are 183 active leases in the Beaufort Sea. Most of these were issued in Lease Sales 186, 195, and 202 and remain to be tested by exploration drilling. These active leases are in the central and eastern part of the Beaufort Sea Planning Area (Figure 1). The Northstar field and Liberty development project are covered by five active leases in the nearshore area off Prudhoe Bay.

The scenario for the Beaufort Sea OCS assumes that companies will explore some of these leases. BOEMRE has had industry inquiries from three operators in the Beaufort Sea indicating possible surveys for 2011 and beyond. Thus, BOEMRE may receive requests to authorize five deep penetration seismic and controlled source electromagnetic activities in a year. If a commercial discovery is confirmed by additional appraisal wells in a location such as the Sivulliq prospect, BOEMRE would anticipate a higher level of activity to occur to acquire 3D data over other geological prospects in the area. Likewise, as lease terms near their expiration dates, operators may increase exploration activities to preserve their leases. Other non-leaseholders, such as ION Geophysical, may propose to collect deep penetration seismic information for potential sale to oil and gas development companies. Operators that are collecting data on speculation to sell to interested parties may collect data over a wide area.

Recent open water marine streamer deep penetration seismic surveys have included up to two support vessels to monitor for marine mammals and provide logistics support. In the Beaufort Sea, fixed wing aircraft are sometimes used for marine mammal monitoring in conjunction with seismic surveys. Seismic survey vessels have not generally used helicopters for logistical support in the Arctic, relying instead on support vessels for refuel, resupply, and personnel transfer. Industry vessels may have the capability to periodically transport personnel, seismic data, and lighter supplies to the mainland via helicopter at an interval of about once every six weeks (definitely less than an average of one flight/day, except possibly during search and rescue operations). As previously discussed, seismic-survey operations may occur beyond the open-water season (e.g., July-December); however, the actual amount of time an individual operation actively collects seismic-survey data (i.e., the airguns are operating) during the open-water season would depend on weather and ice conditions and the operability of its equipment. The smaller support vessel(s) would make occasional trips (1 trip every 2 weeks) to refuel and resupply from several possible locations (e.g., West Dock or Barrow).

Substantial ancillary activities for shallow-hazards and site-clearance surveys have already been conducted at multiple well locations associated with current lease holdings in the Beaufort Sea. Ancillary activities have also been conducted for acquiring biological, physical oceanographic and meteorological information associated with current lease holdings in the Beaufort Sea. The Alaska OCS Region projects no more than four ancillary seismic and other activity notices per year in the Beaufort Sea. Much of this work has to be completed prior to exploration drilling.

Recent drilling operations have been proposed, but have not been conducted:

- In June 2009, Shell submitted an exploration plan proposing to drill two exploration wells in the Beaufort Sea in 2010. Drilling was to be conducted by the *M/V Frontier Discoverer*

with a minimum of six attending vessels used for ice management, anchor handling, oil spill response, refueling, resupply, and servicing drilling operations. BOEMRE conditionally approved this EP in October 2009. In May 2010, the Secretary of the Interior announced a cautious approach in the Arctic and postponed consideration of Shell's proposal to drill up to five exploration wells in the Arctic for the summer because of the need for additional information about spill risks and oil spill response capabilities for the Arctic.

- In May 2011, Shell submitted a revised exploration plan. Shell added a third lease block; increased the total well locations from two to four; increased the drilling season from one open water season until all four wells are drilled in subsequent seasons; adding additional oil spill vessel to the support fleet, adding a purpose built containment system for well control to be housed on the oil spill response barge, etc. In August 2011, BOEMRE approved the Exploration Plan with conditions to be met before any drilling can proceed.

The activities proposed in these exploration plans provide a basis for estimating the level of activity that could occur on existing leases in the Beaufort Sea. The result is the scenario whereby two drill rigs may be expected to operate simultaneously in the Beaufort Sea open water season.

Thirty wells have already been drilled on the Beaufort Sea OCS and BOEMRE estimates that up to 35 wells could be drilled to discover and delineate six new fields (USDOI, MMS, 2003: Table F-2, Appendix F, Vol. 3). If a discovery is made, the same drilling rig would be used to drill additional wells in order to delineate the size of the oil pool. Drilling could continue during the open water season over the next several years. If exploration results in only dry (failed test) wells, then no additional wells would be drilled other than the six test wells.

Mobile, bottom-founded drilling rigs (Steel Drilling Caisson (SDC), CIDS, or similar design) would likely be used to drill prospects in intermediate water depths (10-25 m), and these platforms would operate in both the summer and winter seasons. Exploratory drilling from a bottom founded structure is also possible in shallow waters. Such drilling could occur during the winter solid ice season. For deeper water sites (>25 m), drillships are the most likely platform to drill exploration wells, and drilling activities would be restricted to the open-water season (typically July-November). Offshore operations would be supported by icebreakers and supply boats. All drilling activities would use helicopters to fly crew and lighter supplies to the offshore facilities.

Gravel or ice islands could be constructed as temporary drilling platforms in shallow-water sites and winter drilling operations could be supported by ice roads over the landfast ice. However, it is unlikely that gravel islands would be constructed to drill exploration wells because they would be prohibitively expensive. Ice platforms are restricted to depths of less than 10 m (~33 ft), and most Federal lease areas in the Beaufort Sea are in water greater than 10 m deep. While it is possible that ice platforms may be used as platforms for exploratory wells, drilling from land or offshore islands into Federal areas would be a more common industry strategy. BOEMRE has in the past approved one plan for drilling from an ice platform in the Beaufort Sea (McCovey Prospect), however the plan did not move forward because it did not meet coastal consistency requirements.

Levels of Exploration Activity. BOEMRE anticipates an upper limit of five deep penetration seismic surveys (2D/3D open water marine streamer, ocean bottom cable (OBC), in-ice, and over ice surveys) or marine electromagnetic surveys (CSEM), four ancillary activities, and two drill rigs, including drillships and fixed Gravity Based Structure (GBS), in the Beaufort Sea during any particular year (see Table 2). These are the upper limits (peak number) of BOEMRE-authorized activities during any one year for purposes of our impact analysis (Table 2). If a large prospect is confirmed during exploration drilling activities, deep penetration seismic activity levels are expected to increase above existing levels of activity, but not exceed five surveys per year.

The activities associated with oil and gas exploration generally follow a prescribed sequence of stages; each activity results in a decision to cease exploration, continue on to the next step, or modify

plans. Every company will have their own strategy and timeframe in which to complete the stages. For this reason, companies may be in different stages of exploration (i.e., one company may be proposing to drill while another may be completing ancillary surveys).

There can be a period of more intensive seismic surveying surrounding the lease sales. The level of seismic exploration decreases as companies evaluate the seismic data, perform ancillary activities, and prepare for exploratory drilling. If a company succeeds in locating a commercial field, other companies may intensify their exploration efforts. Likewise, some companies may elect to discontinue investigation of their leases based upon poor results from exploratory wells.

Our current scenarios include a maximum projected level of activity. However, it is not appropriate to assume a peak level of activity over the remainder of the lease terms. The history of OCS oil and gas exploration in the Arctic Region has shown that these peak levels of activity are not sustained year after year, and it is unlikely that all of the categories will be at the peak number during any one year.

Chukchi Sea Scenario

As of September 1, 2011, there are 487 leases as a result of Chukchi Sea Lease Sale 193 (February 2008), and these leases are commonly more than 50 miles from shore in water depths of 100 to 200 ft (Figure 1).

As indicated by the results of Lease Sale 193 that collected \$2.672 billion in bonus bids, it is apparent that industry is again attracted to previously identified prospects. Renewed industry interest for leases and exploration in the Chukchi Sea was partly prompted by higher oil and gas prices and advances in engineering technologies to alleviate some of the difficult conditions in this area. The Chukchi Sea OCS is viewed as one of the most petroleum-rich offshore provinces in the U.S., with geologic plays extending offshore from some of the largest oil and gas fields in North America on Alaska's North Slope. Most government and industry experts agree that this province could hold large oil and gas fields comparable to any frontier area in the world.

When companies acquire leases, their intent is to explore those leases. The level of deep penetration seismic survey activity depends largely on lease term (typically 10 years) and if commercial oil discoveries are made. BOEMRE has had industry inquiries from three operators in the Chukchi Sea indicating possible surveys for 2012 and beyond. Thus, BOEMRE may receive requests to authorize three deep penetration activities in a year that it considers a low level of activity. If a commercial discovery is made in a location such as the Burger Prospect, BOEMRE would anticipate a higher level of activity to occur to acquire 3D data over other geological prospects in the areas.

Recent deep penetration seismic surveys have included up to two support vessels to monitor marine mammals and provide logistics support. As previously discussed, seismic-survey operations may occur throughout the entire open-water season (e.g., July-November); however, the actual amount of time an individual operation actively collects seismic-survey data (i.e., the airguns are operating) during the open-water season would depend on weather and ice conditions and the operability of its equipment. The smaller support vessel(s) would make occasional trips (1 trip every 2 weeks) to refuel and resupply from several possible locations (e.g., Barrow, Wainwright, or Nome).

Substantial ancillary activities for shallow-hazards and site-clearance surveys have already been conducted at multiple well locations associated with current lease holdings in the Chukchi Sea. Ancillary activities have also been conducted for acquiring biological, physical oceanographic and meteorological information associated with current lease holdings. The Alaska OCS Region projects no more than four ancillary seismic and other activity notices per year the Chukchi Sea.

As an example of a recently submitted EP, in 2009 Shell Gulf of Mexico Inc. (Shell) submitted an Exploration Plan (EP) to the MMS/BOEMRE to conduct exploration drilling to evaluate the oil and gas resource potential of three prospects on the company's OCS leases in the U.S. Chukchi Sea (USDOJ, MMS, 2009b). The drilling operations were to be conducted using the *M/V Frontier Discoverer*, a modern drillship that has been retrofitted and ice reinforced for operations in Arctic

OCS waters. Shell proposed to drill exploration wells at up to three of five possible drill sites during the July-October 2010 open-water drilling season. While this proposed activity did not take place, it indicates the interest of leaseholders to conduct exploration drilling in the Chukchi Sea. As Shell has access to multiple drilling platforms, BOEMRE assumes a similar level of activity could be proposed on existing leases in the Chukchi Sea. In May 2011, Shell Gulf of Mexico, Inc. submitted a revised EP for the Chukchi Sea, Alaska. BOEMRE is treating this revised EP as a draft pending resolution of the Sale 193 litigation. The Revised EP provides for a total of six wells, one to be drilled on each of six Sale 193 lease blocks starting in the summer of 2012. Depending on ice conditions two to three wells can be drilled in a single open water drilling season. The EP provides for drilling in subsequent drilling seasons as necessary to drill all six wells.

There are more lessees in the Chukchi Sea than the Beaufort Sea. BOEMRE has received preliminary informal inquiries from both ConocoPhillips and Statoil expressing interest in exploratory drilling activity. BOEMRE currently has two Exploration Plans for the Chukchi Sea and is treating them as drafts unless and until the applicant's leases are confirmed. The activity level requested in these exploration plans is consistent with the number of exploratory drilling projected in the scenario used for this analysis. BOEMRE expects that this level will continue into the foreseeable future. ConocoPhillips has conducted ancillary activities in support of future exploratory drilling using a jackup type drilling unit and has submitted a draft exploration plan. Statoil has conducted deep seismic surveys and is conducting ancillary activities in support of future exploration activity. There is a greater potential for more exploratory drilling activities in the Chukchi Sea than the Beaufort Sea. In recognition of costs, increased safety and oil spill response requirements imposed by BOEMRE following the Deepwater Horizon event, the Alaska OCS Region believes that Chukchi Sea lessees will consolidate and share resources in the near term for exploratory drilling operations. It is reasonable to project that two drilling units will operate simultaneously during the open water season in the Chukchi Sea.

Exploration drilling is proposed for 2012 and could continue at an average rate of one to two wells per year for each drilling platform during the summer open-water season (July-November) with as many as two concurrent drilling operations. Drilling operations are expected to be 30-90 days for each well, depending on the depth to the target formation, downhole difficulties during drilling, and logging/testing operations. Five exploration wells already have been drilled in the Chukchi Sea Planning Area and BOEMRE estimates that up to 10 more wells could be drilled before a commercially sized oil field is discovered and delineated. If two rigs were operating simultaneously, this could take two to four years, depending upon weather and sea ice conditions, depth of the wells, and other factors. After a discovery is made, delineation wells would use the same drilling rig and continue over the next several years. If exploration results in only dry or non-commercial discovery exploration wells, the minimum number of dry or non-commercial wells could be five wells.

Considering water depth and the remoteness of this area, drilling operations are likely to employ drillships or jack-up rigs with icebreaker support vessels. Operations at remote locations in the Chukchi Sea Planning Area would require transportation of materials, supplies, and personnel by different means, depending on seasonal constraints and phase of the operations. These operations might be supported by helicopter, icebreakers and supply boats. Generally, survey support will be by vessel or helicopter. Support-vessel traffic could be one to three trips per week, generally out of Barrow, Nome or Wainwright. Helicopter based support could originate from Barrow, Wainwright, or Point Lay.

All drilling activities would use helicopters to fly crew and lighter supplies to the offshore facilities at a frequency of one to three flights per day. Both helicopter and vessel traffic would be based in either Barrow, or Wainwright or a new shore support location near Point Belcher, which is discussed in the Chukchi Sea Scenario Development Section.

It is important to recognize that seismic survey technologies cannot definitely identify hydrocarbon accumulations or distinguish between oil and gas reservoirs. Drilling is the only method to test geologic prospects for commercial-grade reservoirs and to determine which ones will contain oil and which ones contain gas. This means that exploration activities cannot select oil accumulations to drill and avoid gas accumulations. Furthermore, oil and gas often occur together. Oil reservoirs commonly contain associated-dissolved gas and extend upward into gas-bearing zones (gas caps). In this case, both oil and gas could be recovered by the same facilities. Likewise, gas accumulations often yield hydrocarbon liquids (condensate), so gas and condensate could be recovered through the same facilities. For these reasons, it is more realistic to consider an integrated oil/gas development scenario.

Levels of Exploration Activity. BOEMRE anticipates an upper limit of five deep penetration seismic surveys (2D/3D open water marine streamer, in-ice surveys) or marine electromagnetic surveys (CSEM), four ancillary activities, and two drilling units in the Chukchi Sea during any particular year (see Table 2). These are the upper limits (peak number) of BOEMRE-authorized activities during any one year for purposes of our impact analysis.

The activities associated with oil and gas exploration generally follow a prescribed sequence of stages; each activity results in a decision to cease exploration, continue on to the next step, or modify plans. Every company will have their own strategy and timeframe in which to complete the stages. For this reason, companies may be in different stages of exploration (i.e., one company may be proposing to drill while another may be completing ancillary surveys).

There has been a period of seismic surveying prior to and following Lease Sale 193. The level of seismic exploration decreases as companies evaluate the seismic data, perform ancillary activities, and prepare for exploratory drilling. If a company succeeds in locating a commercial field, exploration efforts may intensify. Likewise, some companies may elect to discontinue investigation of their leases based upon poor results from exploratory wells.

2.2.4.2 Development and Production

Development and production consists of installing a production platform to hold wells and facilities. Subsea pipelines will transport hydrocarbons from the production unit to shore and to the tanker terminal in Valdez. The specific scenarios of each planning area are based on their oil and gas exploration history and the inherent differences between the two planning areas. Development and production scenarios for the Beaufort Sea and Chukchi Sea OCS are described below.

Beaufort Sea Scenario

Development

Until a Development and Production Plan is submitted for approval, BOEMRE can offer only a general description of a possible future project, site-specific conditions, and a hypothetical timeline for development. Prospects in the Beaufort Sea are relatively close to shore and existing infrastructure, so development of smaller projects could be feasible. A likely development scenario for the active leases in the Beaufort Sea OCS is for the discovery and development of up to six new fields with a combined production of 1,380 million bbl (USDOI, MMS, 2003: Table F-1, Appendix F, Vol. 3). The new infrastructure associated with these future projects is listed in Table F-2 and may still be accurate, whereas the schedules for development (USDOI, MMS, 2003: Tables F-3, F-4 and F-5, Appendix F, Vol. 3) have been delayed (production was assumed to start in 2010).

Because there is existing oil and gas infrastructure on the North Slope, new offshore projects will use processing facilities and pipeline systems wherever possible. New onshore pipelines will be constructed to reach the existing gathering system. Pump (or compression) stations at the landfall will be constructed to maintain pressure in the onshore pipeline segments. Depending on the location of the field, a new landfall could be constructed near Cape Simpson for projects in the western Beaufort, with likely overland pipeline corridors south of Teshekpuk Lake through NPR-A to the Kuparuk

field. For projects in the central Beaufort, the facilities at Milne Point, Northstar, or Endicott could be modified to handle new offshore production. For developments in the eastern Beaufort, a new onshore facility in the Point Thomson area would be needed to handle oil or gas production from offshore fields. For onshore pipelines, typically both oil and gas pipelines would be elevated on supports, but large-diameter gas pipelines could be buried in the same corridor.

Offshore construction (platform and pipeline installation) and development drilling operations would be supported by both helicopters and supply vessels from the new shore base. Helicopters probably would fly from the Prudhoe area or the new shore base(s) at a frequency of one to three flights per day during development operations. Support-vessel traffic would be one to three trips per week from either West Dock or the new shore base.

Transportation activities would be more frequent during the construction phase, beginning about three years after the discovery is made and would take another three years for completion of the new facility. To support operations in remote parts of the Beaufort Sea OCS, a new shore base(s) might be needed. Onshore site surveys and construction would begin after a commercial discovery is made. Heavy equipment and materials would be moved to the coastal site using barges, aircraft and, perhaps, winter ice roads. A new airstrip may need to be constructed if the development site is too far from existing airstrips. During this construction phase, there could be one to two barge trips (probably from West Dock) in the summer open-water season. Aircraft (C-130 Hercules or larger) trips could be up to five per day during peak periods. The overall level of transportation in and out of the shore base would drop significantly after construction is completed for both the shore base and offshore platform.

Production

The total lifecycle (exploration through production activities) could be up to 50 years, particularly if gas production occurs after oil production. Considering the typical field sizes assumed in the scenario, oil production could last 15-25 years for individual fields. Field life could be extended 10-20 years if the platform and wells are used for gas production after oil reserves are depleted. The historical experience on the North Slope indicates that oil would be produced first and then followed by gas production through much of the same infrastructure. Essentially, delayed gas production would extend the operational life of facilities for several more decades. Later gas production, however, is contingent on the construction of a gas-transportation system from the North Slope and would require the installation of gas-gathering lines connected to the future export system. Given the current realities about a major gas project and the abundant proven gas resources near Prudhoe Bay, BOEMRE does not expect gas sales from the Beaufort Sea OCS until 2020 at the earliest.

Once an offshore project is constructed, operations largely involve resupply of materials and personnel, inspection of various systems, and maintenance and repair. Little maintenance and repair work is expected on the platform itself, but it is likely that processing equipment might be upgraded to remove bottlenecks in production systems. Well workovers will be made at intervals of 5-10 years to restore flow rates in production wells. Pipelines will be inspected and cleaned regularly by internal devices. Crew changes usually are at weekly intervals.

During production operations, aircraft generally would be smaller with less-frequent flights (2 per day). If the production well were close to existing structures on shore, an ice road might be built. Ice-road traffic would be intermittent during the winter months. During normal production operations the frequency of helicopter flights offshore would remain the same (1-3 per day), but marine traffic would drop to about one trip every 1-2 weeks to the production platform. Marine traffic would occur during the open-water season and possibly during periods of broken ice with ice-reinforced vessels. Some operators have proposed to transport cuttings off site from the Beaufort Sea during exploration drilling. Assuming that this also occurred during production, barges would be used to transport drill cuttings and spent mud from subsea wells to an onshore disposal facility, BOEMRE estimates one

barge trip per subsea template (4 wells). This means that there could be two barge trips (during summer) to the new onshore facility over a period of 6 years.

Produced oil and gas will be transported by subsea pipelines buried in trenches to onshore gathering lines. Oil-gathering lines are connected to Pump Station #1 of TAPS. Oil production would be carried by TAPS across Alaska to the port of Valdez, where it will be loaded on tankers bound primarily for U.S. west coast markets. Gas-gathering lines could be connected to a gas-treatment facility and then transported by a new overland pipeline (buried most of its route) across Alaska, through Canada, to U.S. markets. With later gas production after these oil fields are depleted, the total lifecycle (exploration through production) of the Beaufort Sea scenario could be longer than 50 years.

Chukchi Sea Scenario

Development

Commercial development in the Chukchi Sea OCS would represent a departure from historical trends because only exploration activities have occurred. BOEMRE estimates that the first commercial-size oil discovery would contain 1 Bbbl of recoverable oil. This oil discovery could hold a large volume of natural gas, both in solution with oil and as a separate gas cap, with a total initial reserve of 2.75 trillion cubic feet. However, it is the oil reserves that would support the commercial viability of the project.

The environmental analysis is based on the discovery, development and production of the first offshore oil field in the Chukchi Sea. Although exploration wells could encounter oil and gas “shows” (sub-commercial discoveries), only one of the discoveries will contain large enough oil reserves to justify commercial development. No other developments will occur until this first “anchor” field is established. Recoverable oil resources from this field are predicted to be 1 Bbbl, approximately 90% of which is crude oil and 10% is gas condensate liquid. Lower oil volumes are not likely to be economically viable in this remote, high-cost location.

In the scenario, the lease term would be extended into production and oil, solution gas and condensate would be recovered, but only oil and condensate would be transported off-lease for the first 15 years (from 2020 to 2035). In 2015, construction would begin on a new shore base to support offshore development work and then serve as the oil pipeline landfall and oil processing facility. Until a Development and Production Plan is submitted for approval, BOEMRE can offer only a general description of a possible future project, site-specific conditions, and a hypothetical timeline for development.

Water depth and sea conditions are the two main factors in selecting a platform type. Because the continental shelf is relatively deep in the Chukchi Sea (mostly deeper than 100 ft) and affected by ice movements most of the year, a large bottom-founded platform is likely to be used as a central facility. The platform would hold one to two drilling rigs, production and service (injection) wells, processing equipment, fuel- and production-storage capacity, and quarters for personnel. Although bottom-founded platforms have been used in high-latitude settings worldwide, no platform has operated in environmental conditions equivalent to the Chukchi Sea shelf. Conceptual designs have been proposed that typically are circular in cross-section with wide bases and constructed out of steel or concrete. The platform could be constructed in several component sections, which would be transported to the site and then mated together. The seafloor is expected to be relatively firm, so a prepared berm may not be required. The platform base is pinned to the seafloor and stabilized by its wide base, anchoring system, and ballast in cavities in the concrete structure to resist ice forces.

Because of limited topside space on the platform and widespread area of the oil accumulation, up to half of the total production wells could be subsea wells. The subsea wells would be completed in templates (4 per template), and production would be gathered to the central platform by flowlines (10 in or more in diameter). Subsea well templates would be located within about 15 mi from the central platform. Pending the information collected by site-specific surveys, the subsea equipment and

pipelines could be installed below the seafloor surface for protection against possible deep-keeled ice masses. Drilling on the platform would occur year-round, while subsea wells would be drilled by drillships during the summer open-water season.

A 3-phase production slurry (oil, gas, water) will be gathered on the central platform where gas and produced water will be separated and reinjected into the subsurface. Associated and solution gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery. Subsea technology has advanced to the point where separation could be made by equipment on the seabed; so dual flowlines could include oil/gas mixture and produced water. This strategy would minimize problems with in-line hydrates, leak detection, and processing bottlenecks on the central platform. Shallow disposal wells will handle wastewater and treated well cuttings for on-platform wells. Drilling cuttings and mud wastes from subsea wells could be barged to an onshore treatment and disposal facility at the shore base.

The development scenario for the Chukchi Sea also involves future onshore development activities. At the coast, a new facility would be constructed to support the offshore operations because no suitable facilities exist on the Chukchi Sea coast. All necessary transportation (marine dock, airport) and support (fuel storage, warehouses, crew quarters, and communication systems) would be constructed at this new site. Some construction of support facilities has already occurred in Nome and Wainwright. Another possible location for the shore base would be between Icy Cape and Point Belcher (near Wainwright) because it is along a direct route between the likely offshore area for activities and the existing production facilities around Prudhoe Bay.

Installation of all subsea pipelines will occur during summer open-water seasons, and operations would occur during the same timeframe as the platform construction and installation. The subsea pipelines will be different sizes depending on production rates, distances, and the general development strategy.

Flowlines from subsea well templates to a host platform are assumed to be up to 20 mi long. The main oil pipeline to the landfall will be up to 24 inches in diameter to handle production rates as high as 300,000 bbl/day. The offshore pipeline runs 30-150 mi between the offshore platform and landfall and will be trenched in the seafloor as a protective measure against damage by floating ice masses. Gas pipelines for production volumes will be approximately the same size (10 to 24 in diameter) as those assumed for oil and will likely be installed in trenches in the same corridor as the oil pipeline.

Construction of a new shore base could begin after a commercial discovery is made. Heavy equipment and materials would be moved to the coastal site using barges, aircraft, and perhaps winter ice roads. Transportation activities would be more frequent during the construction phase, beginning about 3 years after the discovery is made, and will take another 3 years for completion of the new facility. During this construction phase, there could be one to two barge trips (probably from either West Dock or Nome) in the summer open-water season. Aircraft (C-130 Hercules or larger) trips could be up to five per day during peak periods, using an existing airstrip. The overall level of transportation in and out of the shore base would drop significantly after construction is completed for both the shore base and offshore platform. During production operations, aircraft generally would be smaller with less frequent flights (2 per day).

Offshore construction (platform and pipeline installation) and development drilling operations would be supported by both helicopters and supply vessels from the new shore base. Helicopters probably would fly from either Barrow or the new shore base at a frequency of one to three flights per day during development operations. Support-vessel traffic would be one to three trips per week from either Barrow or the new shore base.

Production

The lifecycle for production depends on the size of the field and development strategies but, in a typical field, oil production would last 15-25 years. Once the offshore project is constructed,

operations largely involve resupply of materials and personnel, inspection of various systems, and maintenance and repair. Little repair work is expected on the platform itself, but it is likely that processing equipment might be upgraded to remove bottlenecks in production systems. Well workovers will be made at intervals of 5-10 years to restore flow rates in production wells. Pipelines will be inspected and cleaned regularly by internal devices. Crew changes usually are at weekly intervals.

During normal production operations, the frequency of helicopter flights offshore would remain the same (1-3 per day) and marine traffic would drop to about one trip every 1-2 weeks to the production platform. Marine traffic would occur during the open-water season (July-November) and possibly during periods of broken ice with icebreaker-support vessels. Assuming that barges will be used to transport drilling cutting and spent mud from subsea wells to an onshore disposal facility, BOEMRE estimates one barge trip per subsea template (4 wells). This means that there could be two barge trips per year during summer to the new onshore facility over a period of six years for each development requiring subsea wells.

As a typical reservoir management strategy, solution gas recovered as a secondary product with oil is used as fuel for facilities and the excess gas is injected into the reservoir to maximize oil recovery. BOEMRE estimates that approximately 500 million cubic feet of gas will be consumed as fuel by the offshore and onshore facilities. Gas development and production could follow oil production (USDOJ, BOEMRE, 2011). Later in the field life, as the oil production rates decline towards depletion, gas can be produced for sale. The estimated timeframe for oil development activities is given in Table IV.A-2a, Volume 3 of the Lease Sale 193 EIS (USDOJ, MMS, 2007). Subsequent gas production would overlap with oil recovery and last for another 20 years (see USDOJ, BOEMRE 2011: Figure 12). Overall, the timeframe for all activities (exploration to production) could span 50 years.

When the oil resources are depleted, the platform and wells could be used for production of the remaining volume of 2.25 TCF of gas (see USDOJ, BOEMRE 2011: Figure 12). In 2030, additional work would be required to expand and modify the existing shore base to support gas production. Gas production would be phased-in around 2035, and peak gas production would start in 2039. All gas reserves are projected to be depleted in 2054 (see USDOJ, BOEMRE 2011: Figure 12). During a 10 year transition period (2035 to 2044), both oil and gas would be produced from the offshore platform. Natural gas liquid (condensate) would be separated from the gas stream and transported through the oil pipeline to market, so the gas pipeline would carry only dry gas. Two overland pipelines across the National Petroleum Reserve-Alaska (NPR-A) would be needed to transport both oil and gas to the main transportation hub near Prudhoe Bay. This scenario assumes that the TAPS will continue to operate through at least 2044, a new high-capacity gas pipeline system will be operational in 2020, and there is at least 10 years of available gas production from existing infrastructure on the North Slope. Gas production from the Chukchi Sea may not reach market before 2035.

Decommissioning

The end of the economic life of a field occurs when income from production does not cover operating and transportation expenses. Commonly, the economic limit is reached before all of the oil or gas in an accumulation is recovered. Typically, less than 50% of the original oil in place is recovered (Prudhoe Bay is an exception with over 60% recovery). A typical gas field will yield approximately 60-90% of the original gas in place. When the economic limit is reached, procedures to shut down the facility would be implemented. In a typical situation, wells would be permanently plugged and wellhead equipment would be removed. Processing modules will be dismantled and moved off the platform. Pipelines will be decommissioned, which involves cleaning the pipeline, plugging both ends, and leaving it in place, buried in the seabed. Overland pipelines likely to be used by other oil fields could remain. Lastly, the platform would be partly disassembled and removed from the area, and the seafloor site would be restored to some practicable, predevelopment condition. Any slope

protection on gravel islands or causeways would be removed and island or causeway would be allowed to erode away over a period of years. Environmental studies would continue to evaluate the site during and after restoration. The abandonment process could take several years, with studies continuing for even longer. The overall lifecycle from leasing through abandonment of all fields in our scenario is expected to be >50 years.

Other options are possible. After the oil reservoir is depleted, the platform could be converted to a gas-production facility to recover the natural gas that was reinjected during oil production. This option depends on whether a North Slope gas pipeline is built. Conversion of the offshore platform to a gas-production facility could delay permanent abandonment for several decades. Another option is that the platform and pipeline systems could serve as a hub for younger satellite fields in the surrounding area. As a third option, the platform and partially dismantled topside facilities could be used for civilian or military purposes. For each option, abandonment activities would be delayed for decades. Considering the cost of installing this infrastructure (multi-billion dollars), it is unlikely that complete abandonment would be a cost-effective alternative.

2.3 Mitigation Measures

There are a variety of typical design features and operational procedures used to mitigate the potential impacts of petroleum activities. BOEMRE can only authorize activities that are in compliance with the Marine Mammal Protection Act, which, in some ways, can be more protective and restrictive than the Endangered Species Act. BOEMRE encourages leaseholders and other permittees to obtain an incidental take authorization for activities that could “take” marine mammals. The FWS typically authorizes incidental take via a Letter of Authorization (LOA). These authorizations incorporate mitigation measures so that the authorized activities do not have more than a negligible effect on marine mammals (a lower threshold than the ESA). Typical mitigation measures for activities in the Chukchi and Beaufort seas are described below and analyzed in chapter 5. As such measures are continually being revised or updated, and can be site-specific, the list below is not intended as a commitment for any particular activity. The final design features and operational procedures used for mitigation are identified in each LOA prior to commencement of activities in the Alaskan OCS.

In the following sections, BOEMRE will discuss typical mitigation measures relating to Exploration activities and then those specific to Development and Production activities. The final section addresses two new technologies with potential for ameliorating the effects of airguns, as well as several new technologies with potential for replacing airguns as a means of reducing potential adverse effects on marine mammals.

Additional mitigation measures are associated with each lease sale in the form of lease stipulations. Stipulations are requirements that the lessee must follow. Lease sales may also have ITLs (Information to Lessees) and NTLs (Notices to Lessees) associated with them. ITLs and NTLs provide additional information to the lessees on best practices or ways to further mitigate the potential for impacts. For a full list of mitigation measures associated with existing leases in the Beaufort and Chukchi seas, see Appendix C.

2.3.1 Exploration

Mitigation measures are specific to the different types of activities in each phase of oil and gas development. Below, with respect to Exploration, mitigation measures for vessel and aircraft operations are addressed first, and then the typical monitoring protocols and mitigation measures associated with four categories of seismic operations are discussed.

2.3.1.1 Vessel Operations

There are a wide variety of vessels of different types and sizes that operate in support of exploration activities. These vessels typically conform to the following operational procedures with respect to whales, as stipulated in LOAs:

- **Maximum distance.** Operators of vessels should, at all times, conduct their activities at the maximum distance possible from groups of walrus, and must maintain a minimum 800m (1/2 mile) buffer zone from walrus, polar bears and polar bear critical habitat.
- **Changes in direction.** Vessel operators should avoid multiple changes in direction when within 800m (1/2 mile) of walrus; however, those vessels capable of steering around such groups should do so.
- **Changes in speed.** Vessels should avoid multiple speed changes; however, vessels should slow down when near groups of walrus, especially during poor visibility, to reduce the potential for collisions.
- **Groups of walrus.** Vessels may not be operated in such a way as to separate members of a group of walrus.

Some oil and gas exploration activity includes the use of an icebreaker. Icebreakers contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Greene and Moore, 1995). The icebreakers would be required to have marine mammal observers (MMOs) on board whose duties will include watching for and identifying marine mammals, recording their numbers, recording distances, and recording their reactions to the drilling or seismic operations.

2.3.1.2 Aircraft Operations

Aircraft are typically required to operate within specific height and distance parameters with respect to marine mammals. These include the following:

- **Helicopters:** Helicopters may not hover or circle above marine mammals or pass within 800 m (½ mi) lateral distance of groups of walrus or polar bears.
- **Inclement weather:** When weather conditions do not allow a 1,500 ft flying altitude, such as during storms or when cloud cover is low, aircraft may be operated below 1,500 ft, but the operator should avoid known walrus concentration areas and take precautions to avoid flying directly over or within 800 m (½ mi) of walrus.
- **Support aircraft:** Support aircraft must avoid extended flights over the coastline to minimize effects on marine mammals in nearshore waters or the coastline.

For some activities, operators or leaseholders would be required to conduct surveys for marine mammals around their operations, particularly in the Beaufort Sea. Aircraft used for these surveys would typically not fly below 1,000 ft. Aerial marine mammal surveys have not been required in the Chukchi Sea because of a lack of adequate landing facilities, the prevalence of fog and other inclement weather in that area, potentially resulting in an inability to return to the airport of origin, and thereby resulting in safety concerns.

2.3.1.3 Seismic Operations

Seismic operations include deep penetration (primarily marine streamer 2D and 3D surveys; see Table 3) and ancillary activities (high-resolution surveys; see Table 4). MMOs monitor operations in order to activate appropriate mitigation measures to protect marine mammals during activities. Therefore, monitoring protocols are discussed first, followed by mitigation measures in four categories of seismic survey.

Monitoring

Monitoring for marine mammals during seismic surveys will be conducted throughout the period of survey operations by trained MMOs. The MMOs are stationed aboard the survey source vessel. Duties of the MMOs include watching for and identifying polar bears and walrus; recording their numbers, distances, and reactions to the survey operations; initiating mitigation measures; and reporting the results.

The MMOs must be on watch during all daylight periods when the sound sources are in operation and when sound source operations are to start up at night. An MMO shift does not exceed four consecutive hours, and no MMO works more than three shifts in a 24 hr period (i.e., 12 hours total per day) in order to avoid fatigue. MMOs are biologists or local experts who have previous marine mammal observation experience and field crew leaders are highly experienced with previous vessel-based monitoring projects. Qualifications for these individuals are typically provided to the Service for review and acceptance. All observers complete a training session on marine mammal monitoring shortly before the start of their season.

Monitoring Methods. The following are the standard monitoring methods utilized to ensure that appropriate mitigation measures are initiated at the appropriate times.

- **Vantage point:** The observer(s) will watch for marine mammals from the best available vantage point on the operating source vessel, which is usually the bridge or flying bridge. Personnel on the bridge will assist the MMOs in watching for polar bears and walrus.
- **Observer equipment:** The observer(s) will scan systematically with the naked eye and 7 x 50 reticle binoculars, supplemented with 20 x 50 image stabilized binoculars, and night-vision equipment when needed.
- **Safety zones:** The observer(s) will give particular attention to the areas within the “safety zone” around the source vessel. These zones are the maximum distances within which received levels may exceed 190 dB re 1 μ Pa (rms) for polar bears. The MMOs will also monitor the 160 dB re 1 μ Pa (rms) radius for Level B harassment takes. When a marine mammal is seen within the applicable safety radius, the geophysical crew will be notified immediately so that the required mitigation measures can be implemented. It is expected that the airgun arrays will be powered down or shut down within several seconds—often before the next shot would be fired, and almost always before more than one additional shot is fired. The MMO will then maintain a watch to determine when the mammal(s) is outside the safety zone such that airgun operations can resume.
- **General information:** The ship’s position, heading, and speed; the operational state (e.g., number and size of operating energy sources); and the water temperature (if available), water depth, sea state, ice cover, visibility, and sun glare at the time of each marine mammal sighting.
- **Estimated distances:** Distances to nearby polar bears (e.g., those within or near the 190 dB) will be estimated with binoculars (7 x 50) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers will use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water.
- **Observation equipment:** Prior to mid-August, there will be no hours of total darkness in the project area. Onboard MMOs will scan systematically with the naked eye, and the operators will also provide or arrange for the following specialized field equipment for use by the MMOs: reticle binoculars, 20 x 50 image stabilized binoculars, Big Eye binoculars, laser rangefinders, inclinometer, and laptop computers. Night vision equipment will be available for use when needed.

Acoustic Sound Source Verification Measurements. The operator or leaseholder is expected to conduct acoustic measurements of their equipment (including source arrays) at the source and at received levels of 190, 180, and 160 dB re 1 μ Pa (rms). The sound source verification (SSV) tests will be utilized to determine safety radii for the airgun array. The measurements are made at the start of the field season so that the measured radii can be used for the remainder of the survey period.

Reporting. All walrus and polar bear sightings must be reported and include the details specified in the LOA. A report that summarizes the monitoring results and operations as specified in the LOA must be received no later than 90 days after completion of the project. The reports may include:

- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through study period versus operational state, sea state, and other factors affecting visibility and detectability of marine mammals).
- Summaries of the occurrence of power-downs, shutdowns, ramp-ups, and ramp-up delays.
- Analyses of the effects of various factors, influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare).
- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover.
- Sighting rates of marine mammals versus operational state (and other variables that could affect detectability).
- Initial sighting distances versus operational state.
- Closest point of approach versus operational state.
- Observed behaviors and types of movements versus operational state.
- Numbers of sightings/individuals seen versus operational state.
- Distribution around the acoustic source vessel versus operational state.
- Estimates of take by harassment.

Mitigation

The monitoring protocols above are important for ensuring that the following mitigation measures are implemented as appropriate. Mitigation measures vary with the specific category of seismic survey being utilized. Four categories are discussed below.

Vessel-based seismic survey. Design features for vessel-based surveys include:

- **Timing and location:** Timing and locating survey activities to avoid interference with the marine mammal hunts.
- **Minimized energy:** Selecting and configuring the energy source array in such a way that it minimizes the amount of energy introduced into the marine environment and, specifically, so that it minimizes horizontal propagation and limits the size of the acoustic energy source to only that required to meet the technical objectives of the survey.
- **Established safety zones:** Early season field assessment to establish and refine (as necessary) the appropriate 180 dB and 190 dB safety zones, and other radii relevant to behavioral disturbance.

The potential disturbance of pinnipeds during seismic survey operations is minimized further through the implementation of several ship-based mitigation measures, which include establishing and monitoring safety and disturbance zones, speed and course alterations, ramp-up (or soft start), power-down, and shutdown procedures, and provisions for poor visibility conditions.

- **Safety and Disturbance Zones:** Operators are required to use MMOs onboard the survey vessel to monitor the 190 and 180 dB (rms) safety radii for walrus and polar bears and to implement other appropriate mitigation measures. Safety radii for marine mammals around airgun arrays are customarily defined as the distances within which received pulse levels are greater than or equal to 180 dB re 1 μ Pa (rms) for walrus, and 190 dB re 1 μ Pa (rms) for polar bears.

- **Ramp-up:** A ramp-up (or “soft start”) of a sound source array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns until the desired operating level of the full array is attained. The purpose of a ramp-up is to alert pinnipeds in the vicinity to the presence of the sound source and to provide them time to leave the area and thus avoid any potential injury or impairment of their hearing abilities. During a survey program, the operator is required to ramp up sound sources slowly (if the sound source being utilized operates within the frequency spectrum of pinniped hearing). Full ramp-ups (i.e., from a cold start after a shut down, when no airguns have been firing) will begin by firing one small airgun. Ramp-ups are required at any time electrical power to the airgun array has been discontinued for a period of 10 min or more and the MMO watch has been suspended. The entire safety zone must be visible and monitored by MMOs during the 30 min lead-in to a full ramp-up, and clear of marine mammals for 15 minutes prior to beginning the ramp-up from a cold start, to ensure that no marine mammals enter the safety zone.
- **Following a power-down** or shutdown, operation of the airgun array will not resume until the marine mammal has cleared the applicable safety zone. If a marine mammal(s) is sighted within the safety zone during the 30 min watch prior to ramp-up, ramp-up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15 min for pinnipeds. The vessel operator and MMOs will maintain records of the times when ramp-ups start and when the airgun arrays reach full power.
- **During periods of turn around** and transit between survey transects, at least one airgun (or sound source) will remain operational. The ramp-up procedure still must be followed when increasing the source levels from one gun to the full array. Keeping an air gun firing avoids the prohibition of a cold start during darkness or other periods of poor visibility. Survey operations can resume upon entry to a new transect without a full ramp-up and the associated 30 min lead-in observations.
- **Power-downs and Shutdowns:** A *power-down* is the immediate reduction in the number of operating sound sources from all firing to some smaller number. A *shutdown* is the immediate cessation of firing of all sound sources. The arrays will be immediately powered down whenever a marine mammal is sighted approaching near or close to the applicable safety zone of the full arrays but is outside the applicable safety zone of the single source. If a marine mammal(s) is sighted within the applicable safety zone of the single sound source, the entire array will be shut down (i.e., no sources firing). For marine mammals sighted alongside or behind the array, the distance is measured from the array.

In the event that an injured or dead marine mammal is sighted within an area where the operator deployed and utilized airguns within the past 24 hours, the airguns must be shutdown immediately and the FWS notified. If an assessment (certified by the lead MMO onboard) indicates the marine mammal was not a casualty of vessel/seismic operations, the ramp-up may be initiated and the survey continued.

- **Operations at Night and in Poor Visibility:** Most operators conduct seismic operations 24 hr/day. When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, infra-red or night-vision binoculars will be available for use. It is recognized, however, that their effectiveness is limited. For that reason, MMOs will not routinely be on watch at night, except in periods before and during ramp-ups. As stated earlier, if the entire safety zone is not visible for at least 30 min prior to ramp-up, then ramp-up may not proceed. It should be noted that if one small energy source has remained firing, the rest of the array can be ramped up during darkness or in periods of low visibility. Survey operations may continue under conditions of darkness or reduced visibility in some circumstances.

- **Speed and Course Alterations:** If a marine mammal (in water) is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or direct course will be changed in a manner that does not compromise safety requirements. The animal's activities and movements relative to the source vessel will be closely monitored to ensure that the individual does not approach within the safety radius. If the mammal is sighted approaching near or close to the applicable safety radius, further mitigating actions must be taken, i.e., either further course alterations or power-down or shutdown of the airgun(s).

Ocean-bottom Receiver Seismic Surveys. There are no unique mitigation measures required for on-bottom cable or nodal seismic surveys to minimize adverse effects to polar bears or birds. These surveys are conducted after nearshore and the shore-fast ice has disappeared.

In-ice Seismic Surveys. A recent proposal for an in-ice seismic survey incorporated design features and operational procedures that will likely be used for minimizing the potential for impacts to marine mammals in such circumstances. The survey was designed to proceed as follows:

- The survey was scheduled to occur in late September–December to avoid higher local marine mammal abundance.
- The seismic survey would have begun in the deep water area of the northeastern US Beaufort Sea where marine mammals would be least abundant.
- The survey would have proceeded along a course designed in part to avoid interference with marine mammal migrations.

Authorization of an in-ice seismic survey is anticipated to require the same basic mitigation measures as required for open-water vessel-based seismic surveys, with additional measures to account for longer periods of darkness:

- **Safety zones:** As with other seismic surveys, a 180/ 190 dB isopleth zone around the seismic-survey-sound source must remain free of marine mammals before the survey can begin and must remain free of marine mammals during the survey.
- **Observers:** Trained MMOs would watch for and identify marine mammals; recording their numbers, distances, and reactions to the survey operations. The MMOs have the authority to initiate a power down or shut down.
- **Equipment:** The MMOs would have 7×50 reticle binoculars, +20× binoculars, a GPS unit, laptop computers, and night vision binoculars available. The MMOs may use night vision binoculars or floodlights to aid monitoring during periods of darkness.
- **Ramp up:** If the airgun array is powered down for any reason, it will not be ramped up again until no marine mammals are detected within the 190 dB exclusion zone for 30 minutes.

BOEMRE requires a weekly operations report, which includes MMO reports. Any harm or mortality to a marine mammal must be reported to BOEMRE immediately. The MMO reports can be used as a management tool to monitor disturbance events during the survey and to modify survey plans, if necessary.

2.3.1.4 Drilling Operations

Exploration drilling in the Alaskan Arctic can be conducted from manmade gravel islands, ice islands, a steel-drilling caisson, jack-up rig, or drillship (Table 5). The type of drilling platform used depends on water depth, oceanography, ice cover, and other factors. Drilling operations from all but drillships and jack-up rigs could be conducted during the winter months. There are no leases within the spring lead system of the Chukchi Sea and drilling operations are not anticipated to occur in this area.

During operations, drilling activities generate nearly continuous non-pulse sounds. This allows marine mammals approaching the activity to avoid the location well before there is any chance of injury. Mitigation measures are unique depending on the specific circumstances of the drilling operations, as described below.

Drilling from an artificial island

Artificial islands are typically only cost-effective when constructed in shallow water, which limits their utility for existing OCS leases. There are no currently undeveloped leases on or near artificial islands in the Alaskan OCS

Results of sound transmission studies conducted during drilling operations from artificial islands (Seal Island: Davis, Greene, and McLaren, 1985; Sandpiper Island: Johnson et al., 1986; Tern Island: Greene 1997) found that underwater noise near the islands usually was weak and was inaudible beyond 2 km (1.2 mi) offshore.

Drilling using a Steel-Drilling Caisson or Jack-up Rig

These platforms rest on the seafloor and have the potential to be operated during the open-water season, depending on location, water depth, etc.

Sounds from the steel drilling caisson were measured during drilling operations in water 15 m deep with 100% ice cover. The strongest underwater tone was at 5 Hz (119 dB re μ Pa) at a distance of 115 m. The 5-Hz tone apparently was not detectable at 715 m, but weak tones were present at 150-600 Hz. Because sounds attenuate rapidly in water shallow enough for a bottom-founded structure, the estimated source levels are expected to be low for these drilling systems (Greene and Moore, 1995).

Drilling from a Drillship

In a recent exploration plan by Shell Offshore Inc., the source sound levels for the drillship, *Explorer II*, were used as a proxy for modeling sounds likely to be produced by the drillship, *Noble Discoverer*, proposed for use in the Beaufort Sea (Marine Mammal 4MPs Chukchi and Beaufort August 4, 2011). These estimates are considered representative of a typical industry-standard, ice-reinforced drillship that would be used for exploration drilling in the Arctic OCS.

The models predicted that source levels from drilling would not reach the 180 dB rms level and were expected to fall below 160 dB rms at 35 m from the drillship. These near continuous non-pulse source sound levels were not expected to be high enough to cause a temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals.

Drilling activities could cease in certain areas and the mobile platform could be moved to another area in deference to subsistence whaling. Ceasing operations at drilling platforms would avoid drilling-related effects to listed species at the drill site; however, as this measure is highly location-specific and season-specific, this type of mitigation measure cannot be considered to apply to all mobile drilling operations. The mitigation of subsistence marine mammal harvests is a requirement of the Marine Mammal Protection Act, and is not a direct consideration of the Endangered Species Act.

The proposed Shell Offshore Inc. exploration plan included the use of MMOs onboard the drillship and various support vessels to monitor marine mammals and marine mammal responses to industry activities. While not specifically required, these monitoring efforts will help industry/government agencies evaluate the effectiveness of mitigation measures and evaluate adverse effects of the activity on marine mammals. The MMOs would initiate mitigation measures should in-field measurements of the operations indicate conditions represented a threat to the health and well-being of marine mammals.

The Camden Bay Exploration Plan submitted during 2011 included a limited discharge plan. A limited discharge plan includes the containment and shipping out of used drilling muds, cuttings mixed with drilling muds, sanitary and domestic waste, hazardous waste, and bilge water to approved

waste facilities. Such plans may be more practical in some areas but are not assumed to be a mitigation requirement for all drilling operations. Mitigation measures for authorized discharges are described according to relevant requirements of the EPA NPDES permit.

2.3.2 Development and Production

If exploration activities delineate an accumulation of sufficient size, and companies choose to move into production, additional consultation would take place when BOEMRE receives a detailed development and production plan (DPP). The DPP would identify the precise location of the production well and associated facilities such as pipelines to shore. The length of time that a platform remains in production depends upon the size of the discovery, whether other discoveries are made in the area and a variety of economic factors. To date, only one production facility is accessing oil from the OCS (Northstar).

2.3.2.1 Construction

Some construction or maintenance is often associated with new or existing facilities both onshore and offshore. For example, impact hammering activities may occur at any time of year to repair sheetpile or dock damage due to ice impingement. At Northstar, many replacement and repair activities have been scheduled in winter when ice roads provide easier access for moving supplies and equipment and fewer marine mammal species are present. However, construction could occur during winter or during the open water season depending upon the location and type of facilities being built. Laying pipelines offshore in deeper water is typically done during the open water season. Laying pipeline in the transition zone from offshore to onshore and the onshore portions are typically done in winter when ice roads can be constructed on shorefast ice and over tundra. Operators have typically been required to search for polar bear dens prior to starting activities and to have a security person trained in hazing available in case a polar bear comes into the area during operations.

Additional consultation would take place when a development plan is received and specific details on when and where construction would take place are available. Specific mitigation measures would be identified at that time and would be implemented through the consultation process or the LOA process.

2.3.2.2 Electrical Generation

Production activities may include generators for the production of electricity to run pumps and run the platform. These generators create noise that can affect listed species. Radiated sound may be minimized by certain engineering designs or shielding.

2.3.3 Mitigation Measures Considered for Alternative Exploration Technologies and Decreasing Airgun Noise

The impulsive airgun has been under scrutiny and criticism as a sound source for seismic exploration due to the belief that the propagated sound waves may harm marine life during operations. BOEMRE frequently receives comments from stakeholders who suggest that airguns should be replaced by more “environmentally-friendly” alternative technologies and other techniques to mitigate current technologies used in oil and gas exploration. In the following section, BOEMRE provides some clarification on the status of these proposed technologies and why they are not currently practicable. Technologies supplemental to seismic operations such as gravity/gradiometry and controlled source electromagnetics are commercially available and discussed in Section 2.2.4.1.

Some alternative acoustic source technologies put the same level of useable energy into the environment as airguns, but the energy is generated over a longer period of time, resulting in lower peak sound level (i.e., they are quieter). One alternative, the low frequency passive seismic method, relies on naturally produced sounds and does not introduce any sound into the environment. However, these alternative acoustic sources are in various stages of development and none of the systems with

the potential to replace airguns as a seismic source are currently commercially available. These are discussed in detail below along with technology-based mitigation measures that attempted to decrease the noise level of airguns.

2.3.3.1 Alternative Exploration Technologies

H5 Marine Vibrators

Marine vibrators produce vibrations either through a piston within a housing or a current within an electric coil. There are two types of marine vibrators, hydraulic and electric, which are discussed below.

Hydraulic

Hydraulic marine vibrators have been successfully deployed and are comparable to airguns, but lack the low frequency content that is necessary for very deep penetration and are not presently available.

In 1981, Industrial Vehicles International, Inc. (IVI) signed an agreement with Britoil to develop a marine vibrator seismic source. In 1983, after scrapping the first design, IVI began developing a new system with the goal of producing a marine source able to emit a broad band, high amplitude, modulating frequency output. In 1985, the first commercial system was offered (IVI, 2003). The developed system consists of a marine vibrator, vibrator controller, and a Power Unit. The marine vibrator consists of a piston in a housing, with power supplied to the electrical, pneumatic and hydraulic systems by the Power Unit. An alternator, air compressor, and two pressure-driven hydraulic pumps are driven by an air cooled Diesel engine. The source is capable of generating modulated frequencies between 10 and 250 Hz, and can be used in water depths as shallow as one meter. Signals are generated by conventional land vibrator controllers (IVI, 2010).

The system has been tested in various environments from transition zones to deepwater. Acoustic performance tests conducted at the Seneca Lake Facility of the Naval Underwater Systems Center in 1988 evaluated the system and determined that the marine vibrator was deficient in the low frequencies (Johnston, 1989; Walker et al., 1996). A comparison of marine vibrator, dynamite, and airgun sources in southern Louisiana concluded that the marine vibrator was a viable source for environmentally sensitive areas (Potter et al., 1997; Smith and Jenkerson 1998). In transition zones, when coupled with the seafloor, marine vibrators operate like a land vibrator (Christensen, 1989). The best performance is on a seafloor which distributes the vibrator's forces.

Initial deep water tests were conducted in the Gulf of Mexico by Geco-Prakla using a vibrator with an energy output approximately equivalent to a 1000 in³ airgun. Despite limitations of low frequency energy, good definition of reflectors down to three seconds indicated that the system was viable (Haldorsen et al., 1985). In 1996, a commercial field test comparing a six marine vibrator array with a single 4258 in³ airgun was undertaken in the North Sea by Geco-Prakla with the objectives of evaluating cost, reliability, production rate, and quality of the geophysical data. After two weeks of data collection, a comparison between the marine vibrator and the airgun data indicated that the marine vibrator data contained more frequency content above 30 Hz and less frequency content below 10 Hz than the airgun data, but overall the data were comparable. Marine vibrator production rates were slightly lower than those of the airgun, but by the end of the survey, the technical downtime of the marine vibrator was similar to the airgun (Johnson et al., 1997).

Geco-Prakla, a subsidiary of Schlumberger, operated the marine vibrator program, conducting surveys and tests, until 2000 when the exclusive-use agreement between IVI and Schlumberger expired (Bird, 2003). IVI continued to further develop the system into the early 2000's, but they are no longer actively marketing the product because there is no client base for the system. The significant expense to retrofit the marine exploration companies' ships to support marine vibrators is not offset by reduced operation costs or better data quality. IVI presently has marine vibrator systems

that could be used for seismic data collection, but they would require renovation prior to deployment, which could take three months to a year (Christensen, 2010, pers. comm.).

While the hydraulic vibrator system has been used for seismic exploration, the data quality does not surpass that of an airgun; in fact, the absence of the low frequency component limits the usefulness of the tool for deeper targets. There are no cost savings for the user and the system was put on a shelf because there is no client base. This system is presently unavailable for use.

Electric

An electric vibrator system has been in development since the late 1990s. It has the potential to reduce overall sound level compared to airguns, but there are concerns about its reliability.

Petroleum Geo-Services (PGS) began developing an electro-mechanical marine vibrator in the late 1990s. The original system consists of two transducers: the lower frequency (6-20 Hz) “Subtone” source and the higher frequency (20-100 Hz) “Triton” source (Tenghamn, 2005, 2006). Each vibrator is composed of a flexensional shell that surrounds an electrical coil, a magnetic circuit and a spring element. The sound in the water column is generated by a current in the coil, which causes the spring elements and shell to vibrate. Mechanical resonances from the shell and spring elements allow very efficient, high power generation (Spence et al., 2007; Tenghamn, 2005, 2006). The source tow-depth, generally between 5 and 25 m below the sea surface, is selected depending on the frequency and enhancement from the surface reflection which, to a certain degree, directs the acoustic signal downwards.

The reduction of the overall sound level and specifically the frequencies above 100 Hz, which are beyond the useful seismic range, is a major advantage of the system. Another is the reduction of acoustic power in comparison with conventional seismic sources, which occurs because the net source energy is spread over a long period of time (Tenghamn, 2005, 2006).

This system was compared to a 760 in³ airgun along a 2D line in shallow water. A comparison of the data demonstrates that the marine vibrator equals the penetration of the airgun down to 5.5 seconds two-way travel time (TWT) while emitting less acoustic energy into the water. A second test comparing dynamite to the vibrators was run in the transition zone (4-6 feet of water). The transducers were mounted in a frame that was placed on the seabed. The vibrators lost the low frequency component, due to attenuation of the signal, limiting the depth of penetration to approximately two seconds TWT. However, in the shallower sections imaged by the vibrator, the two sources compared favorably (Tenghamn, 2005, 2006). Most of the trials have been conducted in shallow water (< 100m); deeper water tests need to be run to determine performance depth range of the system (Tenghamn, 2010).

The concept was proven to work because the electric vibrator system worked as a source for seismic data during the early period of development. However, unreliability prevented it from becoming a commercial system. PGS spent 2006 and 2007 conducting a feasibility study to improve reliability and testing a newly developed prototype. After that work, PGS developed three additional systems that are currently being tested. PGS does not have a commercial system available for data collection at this time. They project that, if funds were available, it would take two to four years to fully develop and test a system for commercial use (Tenghamn, 2010, pers. comm.).

The electric vibrator system has potential, but needs additional testing. Unless the electric vibrator can produce low frequency waves, the electric system will have the same limitations as the hydraulic system. This system is not available and needs an additional two to four years to fully develop and test for commercial use.

Low-level Acoustic Combustion Source (patented)

The low level acoustic combustion source (LACS) is being promoted as an alternative source for seismic acquisition (Weilgart, 2010). Originally designed as a ship sound simulator for the Norwegian navy, shallow penetration data have been collected in a fjord environment with the LACS system.

The LACS system is a combustion engine with a cylinder, spark plug, two pistons, two lids, and a shock absorber. It creates an acoustic pulse when two pistons push lids vertically in opposite directions; one wave reflects from the sea surface and combines with the downward moving wave. There is no bubble noise from this system as all air is vented and released at the surface, not into the underwater environment. The absence of bubble noise allows the system to produce long sequences of acoustic pulses at a rate of 11 shots per second; this allows the signal energy to be built up in time with a lower amount of energy put into the water (Askeland et al., 2007, 2009). The system design also controls the output signal waveform, which can reduce the amount of non-seismic (>100 Hz) frequencies produced (Spence et al., 2007). The transmitted pulses are recorded by a near-field hydrophone and seafloor and sediment reflections are recorded by a far-field streamer (Askeland et al., 2007, 2009).

Two LACS systems are being offered commercially. The LACS 4A has a diameter of 400 mm, a height of 600 mm and a weight of approximately 100 kg in air. Pulse peak - peak pressure is 0,8 Bar meter or 218 dB re 1 μ Pa @ 1 m. Field test results of the LACS 4A system demonstrate that the system is capable of accurately imaging shallow sediments (~230 meters) within a fjord environment (Askeland et al., 2008, 2009). This system is suitable for shallow penetration towed-streamer seismic surveys or vertical seismic profiling (Askeland et al., 2008).

The second system, the LACS 8A, theoretically has the potential to compete with a conventional deep penetration airgun seismic array. The LACS 8A system has pulse peak - peak pressure of 3 Bar meter or 230 dB re 1 μ Pa @ 1 m. The weight is 400 kg and the diameter is 800 mm. Several LACS units may be operated together to provide an increased pulse pressure (Bjørge Naxys AS, 2010). This system currently does not exist and the project is presently on hold. It would take at least 18 months to build and field test one of these systems if funding were available (Abrahamsen, 2010, pers. comm.).

The higher frequency LACS system has been tested and proven in a fjord environment. However, this system is still largely unproven in other geologic environments and requires additional documentation. The deeper water system, with the potential to compare with airgun seismic data, has not yet been created and does not have funding for development.

Deep-Towed Acoustics/Geophysics System (DTAGS)

The US Navy developed a deep-towed acoustics/geophysics system (DTAGS) to better characterize the geoacoustic properties of abyssal plain and other deep-water sediments. DTAGS has been used successfully to image gas hydrates and very deep water sediments. The system was tested and modified in the early 90's and used in various locations around the world until it was lost at sea in 1997 (Gettrust et al., 1991; Wood et al., 2003).

The second generation DTAGS is based on the original design but with more modern electronics. It uses the same Helmholtz resonator source consisting of five concentric piezoelectric ceramic rings sealed in an oil filled rubber sleeve to generate a broadband signal greater than two octaves. The optimum frequency performance range is between 220 and 1000 Hz with a source level of 200 dB re 1 μ Pa @ 1 m, which is a major improvement over the original DTAGS. The source is extremely flexible, allowing for changes in waveform and decrease in sound level to produce a source amplitude, waveform, and frequency to suit specific requirements (Wood et al., 2003; Wood, 2010).

The DTAGS is towed behind a survey vessel usually at a level of 100 m above the seafloor and a vessel speed of two knots; it can operate at full ocean depths (6000 m). A 450 meter, 48 channel

streamer array is towed behind the source to record the reflected signals. Seismic signals are digitized at each hydrophone and recorded in SEG-Y format in a top-side unit (Wood et al., 2003; Wood, 2010). The DTAGS can also be configured with an aluminum landing plate, which transmits the acoustic energy directly into the seafloor. With this configuration, vertical bottom founded hydrophone arrays are used to receive reflections (Breland, 2010).

Proximity of the acoustic source to the seafloor is an advantage of the DTAGS system. The system has a limit of 1 km penetration in most marine sediments (Wood et al., 2003). It has been used very successfully to map out gas hydrates in the Gulf of Mexico (Wood et al., 2008), Canadian Pacific (Wood et al., 2002; Wood and Gettrust, 2000), and Blake Ridge (Wood and Gettrust, 2000).

There is only one DTAGS in existence at this time. While it has imaged shallow sediments and gas hydrate environments extremely well, the current tool design could not replace a deep penetration airgun array for oil and gas exploration at this time - DTAGS was not designed for this purpose. However, there is no physical limitation to designing a resonant cavity source to simulate the frequency band of air guns. No research is being conducted on this system at this time.

Low Frequency Passive Seismic Methods for Exploration

Low frequency passive seismic methods utilize microseisms, which are faint Earth tremors caused by the natural sounds of the earth, to image the subsurface. A typical survey consists of highly sensitive receivers (usually broadband seismometers) placed in the area of interest to collect data over a period of time. Upon completion of the survey, the data are analyzed and filtered to remove all non-natural sounds, which is most efficiently completed using an automated process (Hanssen and Bussat, 2008). All of the current methods use one of following three sources of natural sounds: natural seismicity, ocean waves, or microseism surface waves.

Natural Seismicity

Natural seismicity uses the Earth's own movements as a source of energy. Two techniques have been developed to utilize this energy source:

- Daylight Imaging (DLI): DLI uses the local seismicity of an area to produce reflection seismic profiles, similar to those recorded in active seismic surveys (Claerbout, 1968). DLI is best used to augment active seismic data, in areas where it is difficult to collect data.
- Local Earthquake Tomography (LET): LET also uses local seismicity of a region to map on the reservoir scale (Kapotas et al., 2003). However, it is used to calculate the velocity structure of the subsurface in 3D by analyzing each earthquake on multiple receivers and generating ray paths instead of cross-correlating the recorded signals. This method requires a longer period of data collection than the other methods to produce results.

Ocean Waves

Ocean waves are used as a sound source for the Sea Floor Compliance (SFC) technique. The method requires that Ocean Bottom Seismometer (OBS) stations with highly-sensitive, broadband seismometers and differential or absolute pressure gauges be installed in water several hundred meters deep. In the right setting, a coarse one dimensional (1D) S-wave velocity model of the subsurface down to the Moho can be generated using the measured water pressure and vertical movement of the seabed caused by large passing ocean waves (Crawford & Singh, 2008).

Microseism Surface Waves

The most successful use of low frequency passive micro-seismic data has been on land where it is easier to isolate the extraneous noise from the natural signal. The technique is also promising in the marine environment. To ensure success of a marine survey: (1) it is imperative that the recording instruments are in proper contact with the substrate (the natural signal may not be accurately recorded

in unconsolidated material) and (2) the increase in both anthropogenic and naturally produced noise in the marine environment is correctly filtered so that it does not mask the signal of interest.

- **Ambient-Noise (Surface-Wave) Tomography [AN(SW)T]:** AN(SW)T uses low frequency (between 0.1 and 1 Hz) ambient noise records to estimate shear wave velocities and structural information about the Earth. The ambient noise used consists mainly of microseism surface waves (Rayleigh and Love waves) (Bussat and Kugler, 2009). This technique requires the use of broadband seismometers to record the low frequency surface waves, which can penetrate to depths of several kilometers (Bensen et al., 2007, 2008). Because the marine environment produces abundant, high-energy surface waves, a few hours or days of acquisition can produce good quality data. The AN(SW)T can be used in areas where seismic data are difficult to collect or in environmentally sensitive areas. While this technology is new and still in need of further testing, the lateral resolution at several kilometer depths may reach a few hundred meters and the resolution may be better than gravimetric or magnetic data, which is promising for oil and gas exploration (Bussat & Kugler, 2009).
- **Surface-Wave Amplitudes:** Surface-Wave Amplitudes is a 1D method that images the geological structure of the sub-surface by analyzing passive acoustic data that have not been geophysically processed. The transformation of incoming micro-seismic surface-waves, scattered at vertical discontinuities, into body waves may produce these data, but the process is not well understood (Gorbatikov et al., 2008).
- **Low-Frequency Spectroscopy (LFS):** LFS is also known as Low Frequency Passive Seismic (LFPS) or Hydrocarbon Microtremor Analysis (HyMAS) tests for an indication of subsurface hydrocarbon accumulation using spectral signatures gathered from the ambient seismic wave field recorded by broadband seismometers. The cause of the spectral anomalies, often called Direct Hydrocarbon Indicators (DHIs), is presently unknown, but the following reasons have been proposed: standing wave resonance, selective attenuation, resonant amplification (Graf et al., 2007), and pore fluid oscillations (Frehner et al., 2006; Holzner et al., 2009). Energy anomalies in the frequency range between 1 and 6 Hz have been observed in known hydrocarbon areas including Mexico (Saenger et al., 2009), Abu Dhabi (Birkelo, 2010), Brazil, Austria (Graf et al., 2007) and south-Asia (West et al., 2010). However, this methodology is highly dependent on the ability to process out all anthropogenic noise and topography (Hanssen and Bussat, 2008). This method is still in the early stage of development and has not been confirmed in the field during all studies (Ali et al., 2007; Al-Faraj, 2007).

Passive seismic surveys cannot replace active seismic acquisition. However, passive acoustic data have the potential to enhance oil recovery at a better resolution than magnetic or gravimetric methods (Bussat and Kugler, 2009) especially in areas that are environmentally sensitive or active seismic operations are difficult. This technique is difficult to use under water due to ambient noise levels; more case studies are needed to document the utility of this methodology.

Fiber Optic Receivers

Fiber optic receivers are receivers that incorporate optical fibers to transmit the received acoustic signal as light. They are most frequently used in the petroleum industry for seismic Permanent Reservoir Monitoring (PRM), a four dimensional (4D) reservoir evaluation application (Maas, et al., 2006). The optical receivers are permanently placed on the seafloor, ensuring consistency and repeatability of the 4D surveys, better signal to noise ratios, and quality of subsequently collected data. Fiber optic systems are not new. Fiber optical components have been used by the military for years in similar applications for antisubmarine warfare and area surveillance and have proven to be highly reliable.

Fiber optic receivers are more sensitive than standard receivers, which allows for smaller airgun arrays to be used. While these receivers offer a benefit to the environment through a decrease in airgun noise, this technology is not presently available for towed-streamer surveys. Fiber optic receivers have not been used in the Alaska OCS due to the lack of large scale offshore production requiring 4D monitoring.

2.3.3.2 Decreasing Airgun Impacts

In addition to alternative methods for seismic data collection, industry and the public sector have actively investigated the use of technology-based mitigation measures to lessen the impacts of airguns in the water.

Air Gun Silencer

One new technology-based measure to lessen the impacts of the airguns currently in use is an airgun silencer, which has acoustically absorptive foam rubber on metal plates mounted radially around the airgun. This technology has demonstrated 0-6 dB reductions at frequencies above 700 Hz, and 0-3 dB reductions at frequencies below 700 Hz. This system has been tested only on low pressure airguns and is not a practicable mitigation tool because it needs to be replaced after 100 shots (Spence et al., 2007).

Bubble Curtain

Bubble curtains are another technology for reducing the impacts of airguns. Bubble curtains generally consist of a rubber hose or metal pipe with holes to allow air passage and a connector hose attached to an air compressor. They have successfully been tested and used in conjunction with pile driving and at construction sites to frighten away fish and decrease the noise level emitted into the surrounding water (Würsig et al., 2000; Sexton, 2007; Reyff, 2009). They have also been used as stand alone units or with light and sound to deflect fish away from dams or keep them out of specific areas (Weiser, 2010; Pegg, 2005).

The use of bubbles as a mitigation measure for seismic noise has also been pursued. During an initial test of the concept, the sound source was flanked by two bubble screens; it demonstrated that bubble curtains were capable of attenuating seismic energy up to 28 dB at 80 Hz while stationary in a lake. This two-bubble curtain configuration was field tested from a moving vessel in Venezuela and Aruba where a 12 dB suppression of low frequency sound and a decrease in the level of laterally projecting sound was documented (Sixma, 1996; Sixma and Stubbs, 1998). A different study in the Gulf of Mexico tested an “acoustic blanket” of bubbles as a method to suppress multiple reflections in the seismic data. The results of the acoustic blanket study determined that suppression of multiple reflections was not practical using the current technology. However, the acoustic blanket measurably suppressed tube waves in boreholes and has the capability of blocking out thruster noises from a laying vessel during an OBC survey, which would allow closer proximity of the shooting vessel and increase productivity (Ross et al., 2004, 2005).

A recent study “Methods to Reduce Lateral Noise Propagation from Seismic Exploration Vessels” was conducted by Stress Engineering Services Inc. under the BOEMRE Technology Assessment & Research (TA&R) Program. The first phase of the project was spent researching, developing concepts for noise reduction, and evaluating the following three concepts: (1) an air bubble curtain; (2) focusing arrays to create a narrower footprint; and (3) decreasing noise by redesigning airguns. The air bubble curtain was selected as the most promising alternative, which led to more refined studies the second year (Ayers et al., 2009). A rigorous 3D acoustic analysis of the preferred bubble curtain design, including shallow-water seafloor effects and sound attenuation within the bubble curtain, was conducted during the second phase of the study. Results of the model indicated that the bubble curtains performed poorly at reducing sound levels and are not viable for mitigation of lateral noise propagation during seismic operations from a moving vessel (Ayers et al., 2010).

3. DESCRIPTION AND STATUS OF THE SPECIES

This section describes basic life history and current population status of ESA listed species. The listed species of concern are polar bears, spectacled eiders, Steller's eiders, Kittlitz's murrelets, and yellow-billed loons. Critical habitat for the polar bear and eiders is also described.

3.1 Polar Bear and Polar Bear Critical Habitat

3.1.1 General Life History of the Polar Bear

Polar bears (*Ursus maritimus*) are apical predators of the Arctic marine ecosystem (Amstrup, 2003) and specialize in hunting ice seals in shore fast and pack ice (Derocher, Lunn, and Stirling, 2004). Polar bears have a circumpolar Arctic distribution, but are not evenly distributed throughout their range (Obbard et al., 2010). The population as a whole is estimated at 20,000-25,000 polar bears (Lunn, Schliebe and Born, 2002; Obbard et al., 2010). The polar bear population is currently divided into 19 management units (stocks or subpopulations). There are two polar bear stocks that commonly occur in Alaska, the southern Beaufort Sea stock (SBS) and the Chukchi/Bering seas stock (CBS). There is considerable overlap between the two in the western Beaufort/eastern Chukchi seas (Amstrup et al., 2005). Recent tagging data suggests that polar bears may be ranging much further than historical data indicated. This may be an artifact of changes in data collection methods or it may be in response to changes in habitat. If polar bear populations are now less discrete than was previously believed, then some members of the Northern Beaufort Sea stock (NBS) may range into the pack ice of the eastern U. S. Beaufort Sea.

Polar bears are a classic *K*-selected species. They have delayed maturation, litter sizes of 1-3 cubs, and high adult survival rates (Bunnell and Tait, 1981). Because polar bears exist in relatively small populations and have low reproductive rates, populations may be detrimentally impacted by small reductions in their numbers (Amstrup, 2000). Their low reproductive rate requires a high rate of adult survivorship to maintain population levels (Amstrup, 2003). USGS reports found a strong correlation between adult survivorship and sea-ice conditions in the SBS population. Briefly, in high ice years adult survivorship is as high as 90%, while in low ice years, adult survivorship dropped to as low as 60%. As variability in survival rates increase, the risk to the population as a whole also increases, even if mean survival rate does not change (Hunter et al., 2007; Regehr et al., 2010; Schmutz, 2009).

Mating occurs from March to May, followed by a delayed implantation in the autumn (Ramsay and Stirling, 1988). In any given year, 30-60% of reproductively mature females either do not breed or are not impregnated (Taylor et al., 1987). Females give birth the following December or January to one to three cubs, which remain with their mother until they are at least 2 years of age (Harington, 1968; Jefferson, Leatherwood, and Webber, 1993). Females will not breed again until they separate from their cubs. In the Beaufort Sea, female polar bears usually do not breed for the first time until they are 5 years of age (Lentfer and Hensel, 1980), giving birth for the first time at age 6. The maximum reproductive age for polar bears is likely well into their 20s (Amstrup, 2003). The average reproductive interval for a female polar bear is 3-4 years, and a female may produce 8-10 cubs in her lifetime (Amstrup, 2003).

A complete reproductive cycle is energetically expensive for female polar bears. When nutritionally stressed, female polar bears can forgo reproduction rather than risk their own survival (Amstrup, 2003). This is possible because implantation of the fertilized egg is delayed till autumn; hence, a malnourished female unable to sustain a pregnancy can terminate the process by aborting or resorbing the fetus (Amstrup, 2003).

Changes in polar bear reproductive success, physical stature, and survival indicate that the status of polar bears in the Southern Beaufort Sea region is changing (Regehr, Amstrup, and Stirling, 2006). The current estimate for the SBS polar bear population is ~1,526 bears and this stock is believed to be declining by about 3% per year (Hunter et al., 2007; USDO, FWS, 2010a). Observations of drowned,

emaciated and cannibalized polar bears have increased (Amstrup, Stirling, Smith, et al., 2006; Monnett and Gleason, 2006). Survival rates of cubs of the year (COY) are significantly lower than they were in previous studies, and there also has been a declining trend in skull size for both cubs and adult males (Regehr, Amstrup, and Stirling, 2006). Although many cubs are being born into the SBS region, more females are apparently losing their cubs shortly after den emergence, and these cubs are not being recruited into the population (Regehr, Amstrup, and Stirling, 2006).

The Chukchi/ Bering seas stock of polar bears ranges throughout the pack ice in the Chukchi Sea and northern Bering Sea and also uses the coastlines of Alaska and Russia. Wrangel Island appears to be an important denning area. The Chukchi/Bering seas stocks southern boundary is determined by the annual extent of the pack ice (Garner et al., 1990). Historically, polar bears ranged as far south as St. Matthew Island (Hanna, 1920) and the Pribilof Islands (Ray 1971) in the Bering Sea, and some bears may have fasted on St. Mathew Island during the summer while awaiting the return of the pack ice in a strategy similar to that of western Hudson Bay bears. The current estimate for the CBS stock of polar bears is ~2000 bears; however, confidence intervals for this stock are too wide to assess current status and trends (USDOI, FWS, 2010b).

In northern Alaska, pregnant females enter maternity dens by late November and emerge as late as early April. Maternal dens typically are located in snow drifts in coastal areas, stable parts of the offshore pack ice, or on landfast ice (Amstrup and Gardner, 1994). Studies have shown that more bears are now denning nearshore rather than in far offshore regions. Data indicate that ~64% of all bear dens in Alaska from 1997-2004 occurred on land, compared to only ~36% of dens from 1985-1994 (Fischbach, Amstrup, and Douglas, 2007). This trend is believed to be related to climate change and changing sea-ice conditions (Fischbach, Amstrup and Douglas, 2007). The highest density of dens onshore in Alaska occurs along the coastal barrier islands of the eastern Beaufort Sea and within the Arctic National Wildlife Refuge (Amstrup and Gardner, 1994; USDOI, USGS, 2007, unpublished data). In the Chukchi Sea, polar bear denning occurs on Wrangel Island, along the Russian coastline, and in Alaska at Cape Lisburne; Cape Beaufort; the barrier islands between Point Lay and Peard Bay; the Kupuk, Kuk, and Sinaruk rivers; Nokotek Point; Point Belcher; Skull Cliff; and Wainwright Inlet. Although most polar bear denning in the Chukchi Sea occurs in Russia, traditional ecological knowledge indicates that denning may be more frequent along Alaska's Chukchi Sea coast than scientific studies previously have been able to quantify (USDOI, FWS, 1995; Kalxdorff, 1997). In addition, the distribution of denning areas may be changing as a result of climate change. Newborn polar bears are among the most undeveloped of placental mammals; therefore, undisturbed maternal dens are critical to protect them during the first two months of life (Amstrup, 2000). Protecting core maternity denning areas is of critical importance to the long-term conservation of polar bears.

The coast, barrier islands, and shorefast ice edge provide an important corridor for polar bears traveling and feeding during fall, winter, and spring months. Late winter and spring leads that form offshore from the Chukchi Sea coast provide important feeding habitat for polar bears. The Alaskan stocks of polar bears usually forage in areas where there are high concentrations of ringed seals, as these are their primary prey (Stirling and McEwan, 1975; Larsen, 1985), although bearded seals, walrus, and beluga whales also are taken opportunistically (Amstrup and DeMaster, 1988). Polar bears are incredibly efficient at digesting seal fat, assimilating as much as 92% of the fat ingested. This efficiency decreases with the presence of hair and bone, which may explain polar bears preference for stripping the fat and some meat from seal carcasses without ingesting the rest (Best, 1985). Polar bears are almost completely carnivorous, although they will feed opportunistically on a variety of foods including carrion, bird eggs, and berries, they may receive little nutritional value from such foods (Smith, 1985; Smith and Hill, 1996; Derocher, Wiig, and Bangjord, 2000). The high cost of locomotion combined with a low level of nutritional value may explain why it is more efficient for polar bears to fast while onshore, supplementing their fast with readily available food sources such as whale carcasses or berries, rather than to actively hunt for alternative food resources (Hurst et al., 1982; Best, 1984; Derocher et al., 1993).

Polar bears prefer shallow-water areas, reflecting similar preferences of their primary prey—ringed seals—as well as the higher productivity in these areas (Durner et al., 2004a). In spring, polar bears in the Beaufort Sea overwhelmingly prefer regions with ice concentrations >90% and composed of ice floes 2-10 km in diameter (Durner et al., 2004b). In summer, bears in the Beaufort Sea select habitats with a high proportion of old ice, which takes them far from the coast as the ice melts. In fact, 75% of bear locations in the summer occur on sea ice in waters >350 m deep, which places them outside the areas of greatest prey abundance. Ringed seals tend to aggregate in open-water areas in the late summer and early fall, where primary productivity is thought to be high (Harwood and Stirling, 1992), placing them out of reach of polar bears summering on pack ice. The distribution of seals and the habitat-selection pattern by bears in the Beaufort Sea suggests that most polar bears do not feed extensively during summer (Durner et al., 2004), which is supported by reports of the seasonal activity levels of polar bears. Amstrup, Durner, and McDonald (2000) found that polar bears in the Beaufort Sea have their lowest level of movements in September, which correlates with the period when the sea ice has carried polar bears beyond the preferred habitat of seals. Conversely, 75% of bear observations in winter occurred in waters <130 m deep. During winter, polar bears prefer the lead system at the shear zone between the shorefast ice and the active offshore ice. This narrow zone of moving ice parallels the coastline and creates openings that are used by seals. Thus, polar bears in winter use a relatively small area of the Beaufort Sea where prey are most abundant and accessible (Durner et al., 2004). Changes in the extent and type of ice cover are expected to affect the distributions and foraging success of polar bears (Tynan and DeMaster, 1997; Schliebe, Rode, Gleason, et al., 2008).

Polynyas, or areas of open water surrounded by ice, are another habitat type that is extremely important to polar bears (Stirling, 1997). Polynyas are areas of increased productivity at all trophic levels in Arctic waters, particularly where they occur over continental shelves, and often are the sites of marine mammal and bird concentrations. The increased biological productivity around polynyas is a key factor in their ecological significance. Polynyas vary in size and shape and may be caused by wind patterns, tidal fluctuations, currents, upwellings, or a combination of these factors (Stirling, 1997).

The polar bear's preferred habitat is the annual ice over the continental shelf and inter-island archipelagos that encircle the polar basin (Derocher, Lunn, and Stirling, 2004). Research indicates that the total sea-ice extent has declined in recent decades, particularly in nearshore areas and in the amount of multiyear ice in the polar basin (Parkinson and Cavalieri, 2002; Comiso, 2002a, b; Stroeve et al., 2007). Polar bears and ringed seals depend on sea ice for their life functions, and reductions in the extent and persistence of ice in the Beaufort and Chukchi seas will have negative effects on their populations (USDOI, FWS, 1995; Schliebe, Evans, Johnson, et al., 2006). Climate change has affected polar bears in Western Hudson Bay (WHB) in eastern Canada, where they hunt ringed seals on the sea ice from November to July and spend the open-water season fasting onshore. In a long-term study, Stirling, Lunn, and Iacozza (1999) correlated decreased body condition and reproductive performance in bears with a trend toward earlier breakup of sea ice. The earlier breakup shortens the bears' feeding season and increases the length of their fasting season. Because ringed seals often give birth to and care for their pups on stable shorefast ice, changes in the extent and stability of shorefast ice and/or the timing of breakup may reduce their productivity. This is important, because the most critical factor affecting the reproductive success, condition, and survival of polar bears is the availability of ringed seal pups from approximately mid-April till breakup (Stirling and Lunn, 1997). As a result of this close predator-prey relationship between polar bears and ringed seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland, 1995). An analysis of the WHB polar bear subpopulation confirms that it has declined by almost 20% in the last 30 years (IUCN/SSG, PBSG, 2005), and that this decline is linked to significant reductions in the apparent survival of ringed seal pups coincident with earlier sea-ice breakup. A similar relationship between reduced adult body size and reduced cub recruitment has

been documented in association with sea-ice decline in the Beaufort Sea (Rode, Amstrup and Regehr, 2010).

Climate change and the resultant decrease in sea-ice availability may explain why some coastal communities have experienced increased bear-human conflicts prior to freeze-up each fall. With earlier sea-ice breakup, polar bears are forced ashore earlier, in poorer nutritional condition, and remain without access to seals for a longer time period. As they exhaust their fat reserves towards the end of the ice-free period, they are more likely to be drawn to human settlements in search of alternative food sources and come into conflict with humans. This increase in polar bear-human interactions may reflect an increase in nutritionally stressed bears searching for food (Amstrup, Stirling, Smith, et al., 2006). Polar bear patrols in Barrow and Kaktovik (supported by the FWS and the Alaska Nanuq Commission) respond to reports of polar bears in or near town and haze the bears away from human habitation. Similar patrols have been instituted in villages in Chukotka (supported by the World Wildlife Fund). These patrols have been very successful in protecting the safety of both humans and polar bears by decreasing human-polar bear proximity.

Summer sea-ice reduction also affects the severity of storm events along the coast of Alaska, with consequent effects on polar bears. When the ice cover is reduced, particularly during late summer, the available open-water surface increases, and waves grow in height. Unusually rough water may be related to changes in the summer sea-ice cover during recent years. Long-term data sets indicate substantial reductions in both the extent and thickness of the Arctic sea-ice cover during the past 20-40 years, with record minimum extent in 2007-2010 and eight of the ten lowest minimums have occurred during the last decade (Perovich, Meier, Maslanik, et al., 2010). In the southern Beaufort Sea there has been an increase in open water in late summer from 14% in 1972 to 39% in 2007 (Wendler, Shulski, and Moore, 2010). Wave heights in the Beaufort Sea typically range from 1.5 m during summer to 2.5 m during fall, although maximum wave heights of 7-7.5 m are expected (Brower et al., 1988). In fact, a late-summer storm in the Beaufort in September 2000 developed waves 6-7 m high at Point Barrow (Lynch et al., 2003). Such large waves increase energetic costs for swimming bears at sea.

Polar bears are excellent swimmers and swim while actively hunting, while moving between hunting areas, and while moving between sea ice and terrestrial habitats. In June, 2005, USGS researchers identified a female polar bear which apparently swam for more than 557 km from Norton Sound back to the retreating pack ice in the Chukchi Sea northwest of Wainwright (Amstrup et al., 2006). In 2008, an adult female polar bear swam 687 km over nine days, and covered an additional 1800 km over roughly two months (Durner, Whiteman, Harlow, et al., 2011). However, these extreme long distance swims have large energetic costs and may result in cub loss as well (Durner, Whiteman, Harlow, et al., 2011).

Swimming is believed to be more energetically costly than walking, which helps explain why bears often will abandon the melting sea ice in favor of land when ice concentrations drop below 50% (Derocher, Lunn, and Stirling, 2004). Polar bears also can become energetically stressed when the pack ice retreats and carries them to deeper waters beyond the productive continental shelf zone. These bears eventually may choose to swim for shore, where annual food resources such as whale carcasses can be found along the coast. Despite being strong swimmers, energetically stressed bears are susceptible to drowning on such long-distance swims. Monnett and Gleason (2006) reported several polar bear mortalities following a severe storm event in the Beaufort Sea in fall 2004. They observed four bears which may have died as a result of one storm and attributed this phenomenon to longer open-water periods and reduced sea-ice cover. In the 2008 record, the collared polar bear with cub was recorded to have covered 687 km of open water over nine days. When re-captured, she had lost her cub and 22% of her body weight (Durner, Whiteman, Harlow, et al., 2011). If such events are recurrent, they could rise to the level of a significant impact on polar bear populations.

Polar bear use of coastal areas during the fall open-water period has increased in recent years (Kochnev et al., 2003; Schliebe et al., 2005; Gleason and Rode, 2009). In fact, nearshore densities of polar bears can be two to five times greater in autumn than in summer (Durner and Amstrup, 2000). Aerial surveys flown in September and October from 2000-2005 have revealed that 53% of the bears observed along the coast have been females with cubs, and that 73% of all bears observed were within a 30-km radius of the village of Kaktovik, on the edge of the Arctic National Wildlife Refuge (Schliebe et al., 2005). Congregations of more than 60 polar bears have been observed feeding on subsistence-harvested whale carcasses near Kaktovik in recent years during the fall open-water period (Miller, Schliebe, and Proffitt, 2006), and as many as 140 polar bears have been observed at walrus haulout sites on Wrangel Island and the north coast of Chukotka (Kochnev, 2002; Kochnev et al., 2003). These observed changes in polar bear distribution have been correlated with the distance to the pack ice at that time of year. The farther from shore the leading edge of the pack ice is, the more bears are observed onshore in fall (Kochnev et al., 2003; Ovsysanikov, 2003; Schliebe et al., 2005; Kochnev, 2006).

Seven or eight or more beach-cast whale carcasses occur annually along the Chukotka coast (Kochnev, 2006) and, in the last 10-15 years, the number of observations of polar bears feeding on marine mammal carcasses along the coast has increased (Kochnev et al., 2003). Such aggregations have occurred repeatedly (Kochnev, 2006). Bear concentrations form on the coast as early as late summer, depending on patterns of ice breakup, and the bears generally concentrate at walrus haulout sites (Kochnev, 2006). In recent years, as many as 50 bears congregated on Kolyuchin Island between August and November (Kochnev et al., 2003; Kochnev, 2006), and from 7-20 bears concentrated in five other areas along the north coast of Chukotka (Kochnev, 2006). In Chukotka, bears appear in great numbers along the coast near the Native village of Vankarem in October and November. These bears frequently come into the village while moving along the coast, where they are attracted by the smell of walrus meat harvested by local Natives. Hunters say that as many as 10 bears a day enter the village (Kochnev et al., 2003).

In Alaska, polar bears also take advantage of beach cast marine mammal carcasses when on shore during the open water season in fall (Kalxdorff, 2003; Kalxdorff, 1998). Polar bears are also drawn to feed on the remains of whale carcasses left as a result of subsistence hunts, and these carcasses may be an important supplemental food source during the open water season (Miller, Schliebe and Proffitt, 2006).

When environmental factors result in minimal ice conditions, successful predation (hunting) by polar bear may be affected. In these situations, walrus haulouts become important feeding resources during autumn. The abundance and predictable nature of available food resources at haulouts contributes to long-term aggregations of polar bears. Considering the regular nature of such aggregations, they likely play an important role in habitat-use patterns of individual bears and their progeny (Kochnev, 2006). According to Nikita Ovsysanikov, Deputy Director and senior research scientist of the Wrangel Island Nature Reserve, the summer and fall of 2002 were particularly bad for polar bears in the Chukchi Sea. Due to poor ice conditions, many polar bears hunting near Wrangel Island were forced ashore in "starving" condition. During such open-sea situations, seals (the polar bear's main prey) become unavailable, and bears are forced to turn to walrus for sustenance. However, walrus did not haul out on Wrangel Island in autumn 2002 as they usually do; as a consequence, the stranded bears suffered a high mortality rate (Ovsysanikov, 2003).

Polar bears may concentrate contaminants because they eat at a higher level on the food chain. Contaminants of primary concern for polar bears in Alaska are petroleum hydrocarbons, persistent organic pollutants (POP) and heavy metals. Contaminant levels in the SBS and CBS subpopulations of polar bears are lower than other regions and health impacts from contaminants have not been recorded in these subpopulations. Impacts from contaminants have been observed in Svalbard. Bernhoft, Skaare, Wiig, et al. (2000) hypothesized that endocrine disrupters were the source of bears found to have pseudohermaphroditism. Skaare et al. (2001a) documented lower immunoglobulin,

retinal and thyroid hormone levels in polar bears with higher levels of polychlorinated biphenyls (PCBs) and hexachlorobenzene (HCB). In a comparison study between Svalbard and Canadian bears, Skaare et al. (2001b) found that bears with higher contaminant loads had suppressed immune systems. As polar bears continue to become more nutritionally stressed, effects from contaminants may become more pronounced in populations with higher exposure level. To date, Alaskan polar bears have relatively low contaminant loads, with no evidence of population level effects. If shipping, mining and oil and gas developments increase in the Arctic as projected, bears may be exposed to additional sources of contamination.

Sport hunting for polar bears has been banned in Alaska since 1972, although polar bears continue to be taken for subsistence and handicrafts by Alaskan Natives. In 1988, the Inuvialuit Game Council from Canada and the NSB from Alaska implemented the Polar Bear Management Agreement for the Southern Beaufort Sea, a voluntary agreement that limited the total harvest from the SBS population to within sustainable levels (Brower et al., 2002). The stipulations contained in this voluntary agreement are more stringent than those contained in the MMPA. Sustainable quotas under the agreement are set at 80 bears per year, no more than 27 of which may be female. This quota is believed to be at or above sustainable levels, based upon recent population estimates (Regehr, Amstrup, and Stirling, 2006). Recent harvest levels (2000-2005) from the SBS stock averaged 37 individuals in the U.S. and 25 individuals in Canada, for an average harvest of 62 bears per year, well within the agreement's quotas (USDOI, FWS, 2011a, unpublished data).

Russia prohibited polar bear hunting in 1956 in response to perceived population declines; however, both sport and subsistence harvest continued in Alaska until 1972. During the 1960s, hunters took an average of 189 bears per year from the CBS population, an unsustainable rate of harvest that likely caused significant population declines. With the passage of the MMPA in 1972, which prohibited sport hunting of marine mammals, the average annual Alaska harvest in the Chukchi Sea dropped to 67 bears per year. However, with the collapse of the Soviet empire in 1991, levels of illegal harvest dramatically increased in Chukotka in the Russian Far East (Amstrup, 2000; USDOI, FWS, 2003). While the magnitude of the Russian harvest from the CBS is not precisely known, current estimates suggest that it is between 30-300 bears per year (Evans, 2011, pers. comm.). Models run by the FWS indicate that this level of harvest of the CBS population is unsustainable, and that an average annual harvest of 180 bears (4.5% of the starting population) potentially could reduce the population by 50% within 18 years (USDOI, FWS, 2003). This simulated harvest level is similar to the estimated U.S./Russia annual harvest for the period 1992-2006, as well as to the unsustainable harvest levels experienced in Alaska in the 1960s, indicating that the CBS stock of polar bears well may be in decline due to overharvest. The FWS calculations were based on a starting population of 4,000 bears, which is believed to fairly characterize a healthy CBS population. From 2000-2005, the reported U.S. harvest levels of the CBS stock averaged 41 bears, while average Russian harvests of the CBS stock are believed to be much higher (Ovsyanikov, 2003; USDOI, FWS, 2003; USDOI, FWS, 2011a, unpublished data).

Compared to harvest levels from the 1980s, Alaskan Native subsistence harvests of polar bears have declined substantially in the Chukchi Sea over the last decade. This decline may be due to a declining polar bear population that provides fewer animals for harvest, changing environmental conditions, decreased hunter effort, or a combination of these factors (USDOI, FWS, 2003).

A treaty between Russia and the U.S. outlining a protective strategy for polar bear harvests in the Chukchi Sea was signed in 2000. Management decisions under the treaty are made by a four person commission made up of one Native and one federal representative from each nation. In June, 2010, the commission agreed to limit the harvest to no more than 19 females and 39 males per year. The harvest limits are split equally between Alaskan and Russian Native hunters. The signatories hope that this legal quota will lead to better management of the CBS stock of polar bears and help to reduce the illegal harvest of CBS polar bears that is believed to have been occurring in Russia (USDOI, FWS, 2011b).

3.1.2 ESA Status of the Polar Bear

The polar bear was listed as threatened throughout its range under the Endangered Species Act on May 15, 2008 (73 *FR* 28212). The status of polar bears worldwide is declining, primarily due to climate changes and the resulting loss of sea-ice habitat. In September 2007, the USGS concluded that projected changes in future sea-ice conditions, if realized, will result in the loss of approximately two-thirds of the world's current polar bear population by the mid-21st century. Because the observed trajectory of Arctic sea-ice decline appears to be underestimated by currently available models, this assessment of future polar bear status may be conservative (Durner et al., 2007). The FWS and the U.S. Geological Survey (USGS) have predicted that some subpopulations of polar bears may become extinct within the next 40-50 years (USDOI, FWS, 2008a).

In June 2005, the IUCN/SSG (World Conservation Union/Species Survival Commission) Polar Bear Specialist Group (PBSG) concluded that the IUCN Red List classification of the polar bear should be upgraded from Least Concern to Vulnerable, based on the likelihood of an overall decline in the size of the total world polar bear population of more than 30% within the next 35-50 years. The principle reason for this projected decline is "climatic warming and its consequent negative effects on the sea-ice habitat of polar bears" (IUCN/SSG, PBSG, 2005).

3.1.3 Polar Bear Critical Habitat

The Final Rule establishing Critical Habitat for the polar bear was published on December 7, 2010 (75 *FR* 76086). The FWS designated a total of 484,734 sq km (187,157 sq mi) of critical habitat for the polar bear in three units.

Unit 1, sea-ice critical habitat, is defined as all waters over the U.S. continental shelf <300 m deep. Polar bears rely on sea ice for hunting, consuming prey, searching for mates, breeding, long distance movements. Additionally, some females den in snow drifts that form along ridges of multi-year sea ice.

Unit 2, terrestrial denning habitat, includes all land within 32 km of the coastline between the U.S./Canadian border and the Kavik River. It also includes all lands within 8 km of the coastline between the Kavik River and Barrow. Polar bears select den sites near the coast, allowing easy access to seals before and after denning. They also select sites that will protect their cubs from weather, disturbance, and predatory male bears. Typical den sites are found in protected areas where deep snow drifts accumulate, for example, along bluffs or riverbanks.

Unit 3, barrier island habitat, includes all barrier islands and spits from the U.S./Canadian border along the Beaufort Sea and Chukchi Sea coastlines and the northern portion of the Bering Sea coastline. It includes St. Lawrence Island, as well as the water, ice and terrestrial habitat within 1.6 km (1 mi) of the barrier islands and associated spits. Polar bears use barrier islands for resting, access to denning and feeding habitat, and during travel along the coastline. Barrier islands often provide a refuge from human activities and potential disturbances.

Excluded from critical habitat are the coastal villages of Barrow and Kaktovik, existing man-made structures e.g., seawalls, docks, pipelines, within oil fields, and existing U.S. Air Force radar sites at Point Lonely, Point Barrow, Oliktok, Bullen Point, and Barter Island.

3.2 Spectacled Eider (*Somateria fischeri*)

3.2.1 General Life History of the Spectacled Eider

Spectacled eider density varies across the Alaskan ACP (Larned, Stehn, and Platte, 2006). Aerial surveys targeting eiders have been conducted annually by the USDOI, FWS since 1992. Data from those surveys suggested that the population was stable between 1993 and 2007, with a 15-year average annual growth rate of 0.987 (0.969-1.005 90% CI). The most recent population index for North Slope breeding spectacled eiders is 6,458 (5,471-7,445 95% CI). This index is adjusted by a

factor that accounts for the number of nests missed during aerial surveys and is used to calculate a North Slope breeding spectacled eider population estimate of 12,916 (Stehn et al., 2006). The North Slope spectacled eider breeding population would represent just over 4% of the world breeding population, calculated to be 296,892 birds (Stehn et al., 2006).

Spectacled eiders do not breed until age 2-3 years. The abundance and distribution of non-breeding eiders is unknown, but they presumably remain at sea. About 12,000 non-breeding birds off the North Slope breeding grounds are unaccounted for. The North Slope population in the fall (Oct.) is estimated to be 33,587 birds (Stehn et al., 2006).

Spectacled eiders are believed to pair on the wintering ground in St. Lawrence Island polynya in the Bering Sea; the male then accompanies the female to her breeding ground. Female spectacled eiders return to their previous nest location for re-nesting.

Spectacled eiders make use of the spring lead system when they migrate from the wintering area. The spring lead system includes the Ledyard Bay critical habitat area (Figure 3.3.4.2-1) and typically has represented the only open-water area along their path at this time. Spectacled eiders in the spring lead system may be somewhat restricted in their movements because of limited open water due to dynamic sea-ice patterns. The spring lead system may become less critical, as the sea-ice sheet has become thinner and melts away from the coast earlier than in the recent past (see Section 4.1.1.1.1 Sea Ice). This could reduce cross-land travel during spring. Once tundra nesting habitats are sufficiently melted out to allow nesting (historically around June 10), most breeding pairs of spectacled eiders leave nearshore coastal areas to begin nesting on the ACP. While unproven, earlier sea-ice melting may allow spectacled eiders to enter leads in nearshore areas of the Beaufort Sea that are closer to breeding sites east of Barrow. This appears in conflict with the 86 spectacled eiders that were counted during migration counts conducted from Point Barrow fall 2002 through spring 2004 (Suydam et al., 2008).

Spectacled eider nesting density on the ACP is variable, ranging from 0-0.95 nests (assumed to be per square kilometer) (Larned, Stehn, and Platte, 2006). The average clutch size of spectacled eiders is 3.5 eggs; incubation lasts 22-24 days, and hatching typically occurs from mid- to late July (Petersen, Grand, and Dau, 2000). Nest-site fidelity and kinship relationship of spectacled eiders is unknown. Female spectacled eiders were shown to nest in close proximity to genetically related individuals, but the mechanism responsible for this kinship (female kin association or extreme natal philopatry) was not confirmed. Studies have shown that common eider females have high fidelity to natal and breeding areas in part, due to restricted female dispersal between island groups (Sonsthagen et al., 2006). However, this relationship remains unproven in spectacled eiders.

Male spectacled eiders leave the nesting area at the onset of incubation, usually by late June, and seek open waters of the Chukchi and Beaufort seas. In the past, those males departing earliest typically return overland to the Chukchi Sea coast, as there is little open water available in the Beaufort Sea. As sea-ice patterns appear to be changing, some late-departing males may be able to make shorter flights to open-water areas of the Beaufort Sea. These eiders presumably replenish energy reserves during the 1-4 weeks it takes them to leave the tundra and arrive at Ledyard Bay.

Males have fidelity to a molting area and return to it post-breeding. Post-breeding males using the Beaufort Sea typically migrate within 7 km of the coast (median distance; Troy, 2003; Petersen, Larned, and Douglas, 1999) as they move to molting areas in the Chukchi Sea or Russia. Many post-breeding male spectacled eiders slowly begin to converge in offshore aggregations in Ledyard Bay starting in July and begin an extended molt, whereby they are flightless for several weeks. There is a continual stream of new spectacled eiders arriving, as birds from other breeding areas such as Russia arrive. Males that breed on the ACP (but return to molting areas in Russia) still make limited use of Ledyard Bay and other coastal areas of the Beaufort or Chukchi seas on their westward migration. On average, most male spectacled eiders arrive at molt locations in Ledyard Bay around the end of the first week of July and depart for wintering areas by the middle of September.

Female spectacled eiders begin to move to coastal areas at the end of their nesting effort. Females whose nests fail early on go to the coast and may linger in nearshore areas. Females are believed to move farther offshore and make greater use of the Beaufort Sea, because the sea ice has retreated later in the season. As with males, these eiders presumably replenish energy reserves during the 1-4 weeks it takes them to leave the tundra and arrive at Ledyard Bay, typically staying within 17 km of the coast (Troy, 2003; Petersen, Larned, and Douglas, 1999). There is a stream of female spectacled eiders arriving at Ledyard Bay to begin their flightless molt. Females with broods might be encountered within 17 km of the Beaufort Sea coastline (median distance, Petersen, Larned, and Douglas, 1999) between late August and early September. Spectacled eider females with broods are the last to arrive at Ledyard Bay. Most females with broods arrive around the end of the first week of September and are flightless for a period of a few weeks.

Movement between North Slope breeding areas and the primary molting area in Ledyard Bay typically takes several weeks, indicating that several stops are made along the way in the Beaufort and Chukchi seas. The physiological importance of the stops during this extended migration is undetermined, but these stops could be very important to molt timing and survival during and after the molt. Smith Bay appears to be a site of concentrated use by female eiders (Troy, 2003).

Ledyard Bay is an important molting area for North Slope-breeding spectacled eiders in the summer (males) and fall (breeding females). In September 1995, approximately 33,000 spectacled eiders were encountered in Ledyard Bay; most were located in a 37-km-diameter circle, with their distribution centered about 67 km southwest of Point Lay and 41 km offshore. Similar numbers and distributions were observed on other aerial surveys (Petersen, Larned, and Douglas, 1999). Using satellite telemetry, Petersen, Larned, and Douglas (1999) determined that most spectacled eiders molting at Ledyard Bay were between 30 and 40 km offshore. The Ledyard Bay area was designated critical habitat for the spectacled eider in 2001 (66 *FR* 9145). The critical habitat area includes the waters of Ledyard Bay within about 74 km (40 nmi) from shore, excluding waters <1.85 km (~1 nmi) from shore.

The molt is an energetically demanding period, and eiders are believed to use Ledyard Bay for molting because of a combination of environmental conditions, abundance/accessibility of prey organisms, and degree of disturbance/predation. Although this relatively discrete molting area is used routinely by spectacled eiders, it does not correlate with known areas of high benthic biomass identified by Grebmeier and Dunton (2000). It may be that eiders are foraging on invertebrates in the water column or in epibenthic habitat. Although benthic biomass also is considered low in the Norton Sound molting area, spectacled eiders are thought to feed on locally abundant large snails (66 *FR* 9145). It is unknown if large snails are abundant in Ledyard Bay.

Based on telemetry data for molt migration in the Chukchi Sea, male spectacled eiders migrate an average of 35 km offshore, and females fly an average of 60 km offshore. Overall, many spectacled eiders remain in Ledyard Bay until forced out by sea ice (typically late Oct. through mid-Nov.). If the sea ice forms later, eiders may remain longer in Ledyard Bay. Following the molt, spectacled eiders move to their wintering area south of St. Lawrence Island in the Bering Sea.

3.2.2 ESA Status of the Spectacled Eider

All spectacled eider populations were listed as a threatened species under the ESA in May 1993 (58 *FR* 27474). Listing was due to an estimated 96% decrease in nesting abundance in the Yukon-Kuskokwim Delta (Y-K Delta) from the 1970s to the early 1990s and uncertainty about the trends in nesting abundance on the Arctic coastal plains in Alaska and Russia. The breeding population on the North Slope currently is the largest breeding population of spectacled eiders in North America. Other major breeding populations are on the Y-K Delta and the Russian ACP.

The Alaskan and Russian populations of spectacled eider were listed as a threatened species in May 1993 (58 *FR* 27474). Although the factors that caused these declines are unknown, a number of

potential contributory factors have been identified. These include lead poisoning, increased predation, changes in food resources and other factors. These, or other still unidentified threats, were believed to have increased mortality above the rate of reproductive replacements. No data are available to show whether similar trends have affected the breeding population in Russia where as many as 40,000 pairs traditionally nested. Contributing factors for listing identified by the FWS (58 *FR* 27474) are:

Habitat Loss. At least 13,400 km² (5,172 mi²) of Alaskan ACP may be spectacled eider-nesting habitat, <3,240 km² (1,250 mi²) of which have been developed as oil-production fields (Section 3.1). No more than 168 km² (~65 mi² or about 1%) of the tundra wetlands within the oil fields have been altered by development. Spectacled eiders nest in low numbers in active oil fields, and breeding-pair densities in Prudhoe Bay are comparable to those in undeveloped regions of the ACP (58 *FR* 27474). The physical loss of habitat is not known to be a factor in the decline of the spectacled eider (58 *FR* 27474).

Habitat also continues to be degraded by lead pellets deposited from subsistence hunting on the Y-K Delta and the ACP nesting grounds (see discussions on Hunting and Lead Poisoning below). Spectacled eider habitats or important habitat components (e.g., prey base, ice distribution, etc.) may be physically modified by climate change.

Hunting. Alaskan and Siberian Natives traditionally have harvested eiders and eggs during migration and nesting. The subsistence harvest, both in Alaska and in northern Russia, remains poorly quantified, and its effects throughout the species range remain unclear (Stehn et al., 1993; USDO, FWS, 1996a). The estimated, annual subsistence harvest on the Y-K Delta from 1985-1992 averaged about 5% of the local nesting population. Hunting of spectacled eiders has been closed for several years, but some mortality due to misidentification is believed still to be occurring. Several thousand are believed killed annually in Russia (European Commission, 2001).

Predation. Spectacled eiders may be adversely affected by increased numbers or increased distribution of predators. Mammalian and avian predators, particularly the Arctic fox, raven, glaucous gull, and parasitic jaeger all eat eider eggs, young, and occasionally adults. Ravens apparently never nested in Barrow until 1991, when a pair began nesting on a manmade structure (Quakenbush et al., 1995). These ravens were observed preying on eider nests. Ravens have expanded into communities and oil developments/associated infrastructure and have the potential to impact nesting eiders. Powell and Backensto (2007) located 88 nests in the Kuparuk and Prudhoe Bay oil fields from 2004-2007. Reducing raven access to landfills at communities and eliminating nests are recommended management actions to prevent the continued spread of ravens across the North Slope (Powell and Backensto, 2007).

Several raptors also could make use of artificial nesting sites and prey upon eiders or their young. Eiders historically nested in association with geese, possibly as a strategy to reduce predation losses, but when the numbers of geese declined sharply during the past few decades in Alaska, fox predation on eider eggs may have increased. Similarly, new fill pads could provide additional denning sites, which could allow foxes to expand their range/density and increase predation on nesting spectacled and Steller's eiders.

Lead Poisoning. Regulations requiring the use of nontoxic shot for hunting waterfowl, cranes, and snipe in Alaska were implemented during the 1991-1992 migratory bird-hunting season (64 *FR* 47512). Lead shot still is used by some coastal residents of Alaska and Russia for hunting waterfowl, and residual lead shot remains on the tundra or in shallow ponds for years, posing a prolonged risk to eiders. Deposition of lead shot in foraging habitats used by spectacled eiders remains a serious threat to the recovery of this species (64 *FR* 47512, USDO, FWS, 1996a).

Confirmed mortalities of spectacled eiders were documented on the Y-K Delta (1992-1994) (Franson et al., 1995). Thirteen of 112 (~12%) spectacled eiders x-rayed had shot in their gizzards (Flint, Petersen, and Grand, 1997). Based on blood-lead levels, ~7% and 13% of spectacled eiders captured

prior to nesting has been exposed to lead, and lead exposure of females increased with date (from nesting through brood-rearing) (Flint, Petersen, and Grand, 1997). Approximately 21% of the 43 spectaclered eider broods monitored using blood-lead levels included <1 duckling exposed to lead by 30 days post-hatch or roughly 12% of all ducklings sampled. Although the level of lead exposure appeared to be at sublethal levels, exposure seemed to be greatest for successfully breeding females, or the most productive segment of the population (Flint, Petersen, and Grand, 1997).

Flint and Grand (1997) estimated that 40-60% of observed female mortality of radio-marked individuals resulted from exposure to lead, which probably has increased from historic levels. Follow-up work by Grand et al. (1998) indicated that adult female survival estimates for unexposed versus exposed (before hatch) spectaclered eiders were 78% and 44%, respectively. Exposure to lead can lower the annual female survival rate by 34%. They suggested that the majority of mortality likely occurred after brood-rearing away from the breeding grounds and that lead exposure may be limiting the recovery potential of spectaclered eiders on the Y-K Delta. Exposure to lead shot similarly may affect spectaclered eiders in some areas of the ACP.

Ecosystem Change. Marine spectaclered eider habitat in the United States may include some or all of the Northern Bering Sea, the Chukchi Sea, and the western Beaufort Sea. Changes in the Arctic ecosystem that may be affecting spectaclered eiders are evident (Derome et al., 2004). For example, research indicates that the size of clams available to the world's population of wintering spectaclered eiders has shifted to a smaller species, possibly affecting population energetics necessary for subsequent breeding and nesting (Lovvorn et al., 2003).

Recent studies suggest that warming trends are causing rapid change in benthic prey communities in the wintering areas. These changes included a shift in species abundance, distribution, and composition, which could decrease their value to spectaclered eiders (Lovvorn et al., 2008; Grebmeier, Cooper, Lovvorn, et al., 2008); however, Merrill and Konar (2008) suggested that current benthic invertebrate communities are patchy and are likely at higher levels compared to the 1970s. These same warming trends appear to be affecting the distribution and abundance of sea ice, which eiders roost on to save energy. Without sea ice, eiders float on the water, losing energy, and may be unable to meet winter energy requirements (Lovvorn et al., 2008).

3.3 Steller's Eider (*Polysticta stelleri*)

3.3.1 General Life History of the Steller's Eider

In Alaska, Steller's eiders primarily nest in two geographic areas: on the Y-K Delta and on the North Slope near Barrow. Most of the world population of Steller's eiders nests in Arctic Russia from the Yamal Peninsula to the Kolyma Delta (Nygard, Frantzen, and Svazas, 1995). Less than 5% of the breeding population nests in Arctic Alaska (Rothe and Arthur, 1994). It is the least-abundant eider in Alaska, with a discontinuous historic breeding range along the coast from the Alaska Peninsula northward to the Beaufort Sea (Cooke, 1906; Rothe and Arthur, 1994; USDOI, FWS, 1996b).

During extensive aerial surveys of Kasegaluk Lagoon in 1991, Johnson, Wiggins, and Wainwright (1992) and Johnson, Frost, and Lowry (1992) found Steller's eiders in one of three survey years. During 1991, there was 0.04 Steller's eider per km². Although Steller's eiders may occur at greater densities outside Kasegaluk Lagoon, the total numbers probably are low given the small numbers that breed on the North Slope. On the North Slope, the greatest breeding densities were found near Barrow (Quakenbush et al., 2002); although they do not breed every year when present (Suydam, 1997a). The calculated average nesting density across the North Slope during 2002-2006 was 0.0045 bird/km² (USDOI, FWS, 2007).

Paired male Steller's eiders depart the North Slope after the nest is initiated in mid- to late June. Because Steller's eiders occur in such low numbers on the North Slope, it is difficult to observe large migrations by males after nest initiation or post-nesting females and young-of-the-year, as is the case with king and common eiders. It might be reasonable to expect that their movements would be

loosely bounded by the distance of ice from shore and the water depth. It is unlikely that Steller's eiders would be farther than 24 km offshore, because the water depth would be beyond their diving capability and the males likely would be traveling over sea ice. Only 20 Steller's eiders were counted during migration counts conducted from Point Barrow fall 2002 through spring 2004 (Suydam et al., 2008).

In some years, for unknown reasons, paired eiders leave the North Slope without initiating a nest. In breeding years, an average of 5.5 eggs that hatch after 26-27 days of incubation (Fredrickson, 2001). Female eiders and their young-of-the-year typically depart the North Slope from late September to early October (Johnson and Herter, 1989).

Unlike spectacled eiders, Steller's eiders do not molt in the Chukchi Sea. Martin (2001, pers. comm.) used satellite telemetry to study the fall movements of Steller's eiders. During molt migration, Alaskan breeding Steller's eiders stop and rest in areas of the Alaska Chukchi Sea, often in nearshore waters (within 2 km of shore) near Ledyard Bay and Icy Cape. There was less use at more northerly locations near Wainwright and Peard Bay. More males than females migrated from Alaska to areas along the coast of Chukotka. Males that did not go to Chukotka spent more time on the Alaska Chukchi Sea coast. The primary molting areas are near Kuskokwim Shoals or in lagoons on the north side of the Alaska Peninsula.

3.3.2 ESA Status of the Steller's Eider

The Steller's eider was petitioned in December 1990 to be listed as threatened under the ESA. Listing range-wide did not appear to be warranted given the relatively large number (~138,000) of Steller's eiders observed on the wintering area(s) in southwest Alaska. However, the Alaskan breeding population was listed as threatened on June 11, 1997 (62 *FR* 31748), based on an apparent contraction of the species' breeding range in Alaska and due to a perceived increase in its vulnerability to extirpation. The Alaskan nesting population of Steller's eiders was listed because of (1) its recognition as a distinct vertebrate population segment, (2) a substantial decrease in the species' nesting range in Alaska, (3) a reduction in the number of Steller's eiders nesting in Alaska, and (4) the vulnerability of the remaining breeding population to extirpation. Three nesting populations of Steller's eiders are identified: (1) western Arctic Russia, (2) eastern Arctic Russia, and (3) Arctic Alaska (Nygard, Frantzen, and Svazas, 1995). Specific reasons the FWS listed the Alaskan nesting population are:

Habitat Loss. The direct and indirect effects of future oil and gas development within the National Petroleum Reserve-Alaska (NPR-A), and future village expansion (e.g., at Barrow), were cited as potential threats to the Steller's eider. Within the marine distribution of Steller's eiders, perceived threats include marine transport, commercial fishing, and environmental pollutants.

Hunting. Although not cited as an original cause in the decline of Steller's eiders, the take of this species by subsistence hunters is now cited as a threat to the population of Steller's eiders near Barrow (73 *FR* 76994, 2008). Steller's eiders from the Alaska population are known to use marine waters off the Russian coast, suggesting that Steller's eiders from the Alaska population possibly could be shot in Russia. Hunters from four Russian villages are reported to have shot from 3,000-4,500 Steller's eiders annually in the 1990s (Syroechkovski and Zockler, 1997). Steller's eiders continue to be shot on the North Slope despite a ban on this practice and it appears that 10% or more of the Alaska-breeding population of Steller's eiders has been lost due to mortality from hunting (73 *FR* 76994, 2008). In 2008, 27 Steller's eiders were found dead at Barrow between June and August 2008; of these, 20 (74%) were shot. It is unclear if the effect of a similar harvest is affecting the remnant breeding Steller's eider population on the Y-K Delta. The FWS concluded that the subsistence hunt resulted in an unknown amount of shooting and disturbance that has caused the direct loss of nests, eggs, young, and adults in breeding years and that mortality from hunting appears to be the greatest current threat to the Steller's eider (73 *FR* 76994, 2008).

Predation. Increased predation by Arctic foxes resulting from the concurrent crash of goose populations is cited as a possible contributing factor to the decline of the Steller's eider on the Y-K Delta. The potential for increased predation near villages resulting from the villages' associated gull and raven populations also was cited as a potential threat to this species. Ravens apparently never nested in Barrow until 1991, when a pair began nesting on a manmade structure (Quakenbush et al., 1995). These ravens were observed preying on eider nests. Ravens have expanded into communities and oil developments/associated infrastructure and have the potential to impact nesting eiders. Powell and Backensto (2007) located 88 nests in the Kuparuk and Prudhoe Bay oil fields from 2004-2007. Reducing raven access to landfills at communities and eliminating nests are recommended management actions to prevent the continued spread of ravens across the North Slope (Powell and Backensto, 2007).

Lead Poisoning. The presence of lead shot in the nesting environment on the Y-K Delta was cited as a continuing potential threat to the Steller's eider. Regulations requiring the use of nontoxic shot for hunting waterfowl, cranes, and snipe in Alaska were implemented during the 1991-1992 migratory bird-hunting season (64 *FR* 47512). Local problems with lead in the Arctic still exist, particularly in areas where lead shot was or still is widely used for hunting. Lead pellets will continue to be eaten by birds as long as they remain in the environment. Effects of lead poisoning are apparent in some birds, such as the Steller's eider in Alaska (Derome et al., 2004).

Ecosystem Change. The FWS cited direct and indirect changes in the marine ecosystem caused by increasing populations of the Pacific walrus, gray whale, and sea otter as potential causes of the decline of Steller's eiders (62 *FR* 31748-31757). Subsequent declines in sea otter populations (65 *FR* 67343) and continuing declines in Steller's eider populations suggest that otters were not responsible for a decline in eider numbers. In addition, changes in the commercial fishing industry also were cited as perhaps causing a change in the marine ecosystem, with possible effects on eiders. However, the FWS (2002a) is unaware of any link between changes in the marine environment and contraction of the eider's breeding range in Alaska.

Overall, one or more of these factors/threats could reduce survivorship and/or recruitment and, over time, be the underlying cause of Steller's eider decline.

3.4 Kittlitz's Murrelet (*Brachyramphus brevirostris*)

3.4.1 General Life History of the Kittlitz's Murrelet

This species may nest as far north as Cape Beaufort (100 km northeast of Cape Lisburne) in the Amatusuk Hills. Observations of breeding Kittlitz's murrelets are sparse within the Proposed Action area. Thompson, Hines, and Williamson (1966) observed a nest several miles inland on the Lisburne Peninsula northeast of Cape Thompson near Angmakrok Mountain. Breeding farther north is unlikely due to lack of suitable habitat (Day, Kuletz, and Nigro, 1999). The Lisburne Peninsula has not been searched for Kittlitz's murrelets since 1983 (USDOI, FWS, 2004a). These birds are solitary nesters and extensive survey effort is required to determine local abundance. Due to limited survey efforts, the size of the Kittlitz's murrelet breeding population in the Lisburne Peninsula area remains uncertain.

Murrelet foraging areas may occur in or near the action area. Kittlitz's murrelets have been observed on a regular basis in the Chukchi Sea as far north and east as Point Barrow (Bailey, 1948) and occur in the Beaufort Sea (USDOI, FWS, 2006a). Regular observations of Kittlitz's murrelets at sea were noted in late summer and early fall by Divoky (1987), but they have not been subsequently observed by others on similar cruises in the Chukchi Sea, suggesting that there is a great deal of annual variation in their occurrence in the Chukchi Sea. The most recent reports for Kittlitz's murrelet in the Chukchi Sea were of 66 individuals just west of Barrow during a cruise in September-October 2007 (Renner, Hunt, and Kuletz, 2008).

3.4.2 ESA Status of the Kittlitz's Murrelet

This bird is listed as a candidate species (Listing Priority Number 2) throughout Alaska under the ESA (75 FR 69222). The FWS defines a candidate species as "... one for which we have sufficient information to prepare a proposed rule to list it because it is in danger of extinction or likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

3.5 Yellow-billed Loon (*Gavia adamsii*)

3.5.1 General Life History of the Yellow-billed Loon

Yellow-billed loons typically nest near large, deep, tundra lakes where they nest on low islands or near the edges of lakes to avoid terrestrial predators (Johnson and Herter, 1989). Johnson, Wiggins, and Wainwright (1992) reported densities of fewer than 0.01 birds/km² in Kasegaluk Lagoon during aerial surveys from 1989-1991. Over the 3 years, there were only 20 yellow-billed loons observed during these aerial surveys. These low numbers are not surprising given that these aerial surveys were conducted in July through September and were only conducted over the lagoon, not tundra, habitat. Similarly, Dau and Larned (2005, 2006, 2007) observed 23, 99, and 1 yellow-billed loon(s), respectively, during a late-June survey of the coast and barrier islands between Omalik Lagoon and the Canadian Border. These surveys did not include terrestrial/tundra habitats.

Threats to the species include oil and gas development; human disturbance; increased predation; small population size and low productivity; marine health; incidental by-catch from fishing, hunting; and the inadequacy of existing regulatory mechanisms.

Larned, Stehn, and Platte (2006) surveyed terrestrial habitat on the ACP as part of the eider breeding-population survey. In 2006, the yellow-billed loon population index was unchanged from the 2005 survey, and slightly above the long-term average and continued an erratic pattern and slight, although non-significant, upward trend. These low numbers, patchy distributions, and specific habitat requirement may make yellow-billed loons more susceptible to environmental perturbations such as disturbance, habitat alterations, and oil spills than other loon species that are more abundant and widely distributed and that are able to exploit a greater diversity of habitats (Hunter, 1996). Continuing effects of climate change could make tundra lakes larger (and suitable for use by nesting yellow-billed loons) in the near term. Ultimately, however, the loss of permafrost could result in the widespread decline of wetlands on the ACP, including tundra lakes used by nesting yellow-billed loons.

Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the North Slope, primarily between the Meade and Colville rivers in the NPR-A, it is likely that there are fewer than 1,000 nesting pairs, because some of the 3,300 are non-breeders. Additionally, there are approximately 1,500 yellow-billed loons, presumably juvenile non-breeders that remain in nearshore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the North Slope breeding grounds and nearshore marine habitat (Earnst, Stehn, Platte, et al., 2005).

Satellite tagging of eight yellow-billed loons from the Alaska Coastal Plain showed that in late September most yellow-billed loons leave the Chukchi Sea near Point Hope and cross over to the Chukotsk Peninsula, continuing on towards the Kamchatka Peninsula and, less often, the Kuril Islands (Rizzollo and Schmutz, 2008). This suggests that birds wintering in the Pacific Ocean do not originate from the North Slope breeding population; however, the yellow-billed loon is relatively rare in Arctic tundra regions (North, 1994).

3.5.2 ESA Status of the Yellow-billed Loon

In the past 3 years, a status assessment and Conservation Agreement have been developed (Earnst, 2004; 71 *FR* 13155). This bird is listed as a candidate species (Listing Priority Number 8) throughout Alaska under the ESA on March 25, 2009 (74 *FR* 12931).

4. ENVIRONMENTAL BASELINE

For the purposes of interagency consultations under Section 7 of the ESA, the environmental baseline is defined to include the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process (50 CFR 402.02).

Factors Contributing to the Baseline Status of Listed Species

The following factors have had or are having potential effects on listed species:

- Acoustic environment
- Pollution and contaminants
- Marine vessel-traffic
- Research activities
- Oil- and gas-related activities
- Climate change

To understand how these factors contribute to the species status the geographic and temporal scope of the baseline need to be considered.

Geographic Scope of the analysis: The geographic area considered in the analyses includes the Chukchi and Beaufort seas in U.S. waters that include the ranges of the following species:

- Southern Beaufort Sea polar bear
- Chukchi/Bering Sea polar bear
- Steller's eider
- Spectacled eider
- Kittlitz's murrelet
- Yellow-billed loon

Temporal Scope of the analysis The baseline includes the period beginning with the start of commercial whaling in the Arctic and continuing through present time. Whaling in the 1850s introduced the most recent period of dramatic change to the biological resources of the Arctic as well as introducing a period of rapid cultural change.

4.1 Acoustic Environment

4.1.1 General Description of Sound

Introduction to Acoustics

Most of the following information is taken as an excerpt from a draft seismic and drilling EIS being developed by NMFS and BOEMRE (USDOC, NMFS, 2011).

Sound Characteristics

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. When a source vibrates or creates an impulse, it compresses the molecules in the adjacent medium (water or air) and creates a region of high pressure. As the surface of the vibrating object moves back toward its original position, the molecules of the surrounding medium are pulled back and a region of low pressure results. These are called *compressions* and *rarefactions*,

respectively. The speed at which these compressions and rarefactions travel away from the source depends on the compressibility and density of the media and is called the *speed of sound*. The layers of compressions and rarefactions result in a *sound wave*. Sound waves travel much faster in water than in air.

Sound is generally described in terms of frequency (or pitch), intensity, and temporal properties (short or long in duration). The following text provides a general description of these terms. For more details, there are several publications and books that provide detailed overviews of acoustics, such as Richardson, Greene, Malme, et al. (1995) and Au and Hastings (2008) for underwater sound, and Harris (1998) for airborne sound.

Frequency is a measure of how many times each second the crest of a sound pressure wave passes a fixed point; it is measured in *Hertz* (Hz). For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. A particular tone that makes the drum skin vibrate 100 times per second generates a sound pressure wave at 100 Hz, and this vibration is perceived as a tonal pitch of 100 Hz. Sound frequencies between 20 Hz and 20,000 Hz are within the range of sensitivity of the best human ear. Some mysticetes (baleen whales) produce and likely hear sounds below 20 Hz, while odontocetes (toothed whales) produce and hear sounds at frequencies much higher than 20,000 Hz (also reported as 20 kilohertz (kHz)).

Acoustic *intensity* is defined as the acoustical power per unit area. The intensity, power, and energy of a sound wave are proportional to the average of the squared pressure. Measurement instruments and most receivers (humans, animals) sense changes in pressure which is measured in Pascals (Pa). Pressure changes due to sound waves can be measured in Pa but they are more commonly expressed in *decibels* (dB). The decibel is a logarithmic scale that is based on the ratio of the sound pressure relative to a standard reference pressure p_{ref} . Different standard reference pressures are used for airborne sounds and underwater sounds. The airborne standard pressure reference is $p_{\text{ref}}(\text{air}) = 20$ microPascals (μPa), where $1 \mu\text{Pa} = 0.000001 \text{ Pa}$. The underwater standard reference pressure is $p_{\text{ref}}(\text{water}) = 1 \mu\text{Pa}$. The formula used to convert a pressure p measured in μPa to sound pressure level P measured in dB is $P = 20 \log_{10}[p/p_{\text{ref}}]$. Because of the logarithmic nature of the decibel, sound levels cannot be added or subtracted directly. If a sound's pressure is doubled, its sound level increases by 6 dB, regardless of the initial sound level. This can be illustrated by considering a sound having pressure p_1 ; it has decibel level $P_1 = 20 \log[p_1/p_{\text{ref}}]$. Now consider a sound with twice the pressure: $p_2 = 2p_1$. It has decibel level $P_2 = 20 \log[p_2/p_{\text{ref}}] = 20 \log[2p_1/p_{\text{ref}}] = P_1 + 6 \text{ dB}$.

Sound Metrics

Three metrics are commonly used for the evaluation of underwater sound impacts: peak pressure, root-mean-square (RMS) or sound pressure level, and sound exposure level (SEL). Figure 3.1-4 shows a representation of a sinusoidal (single-frequency) pressure wave to help illustrate the various metrics. The amplitude of the pressure is shown on the vertical axis, and time is shown on the horizontal axis. The pressure of the wave is shown to fluctuate around the neutral point. The peak sound pressure is the absolute value of the maximum variation from the neutral position; therefore, it can result from either compression or a rarefaction. The *peak-to-peak sound pressure* is the difference between the maximum and minimum pressures. The average amplitude is the average of absolute value of pressure over the period of interest. The *RMS amplitude* is a type of average that is determined by squaring all of the amplitudes over the period of interest, determining the mean of the squared values, and then taking the square root of this mean. The RMS amplitude of an impulsive signal will vary significantly depending on the length of the period of interest (DOSITS 2011). *SEL* is a metric that is related to the sound energy per area received over time, though it does not have energy units. It is proportional to the square of the sound pressure and the time over which a sound is received.

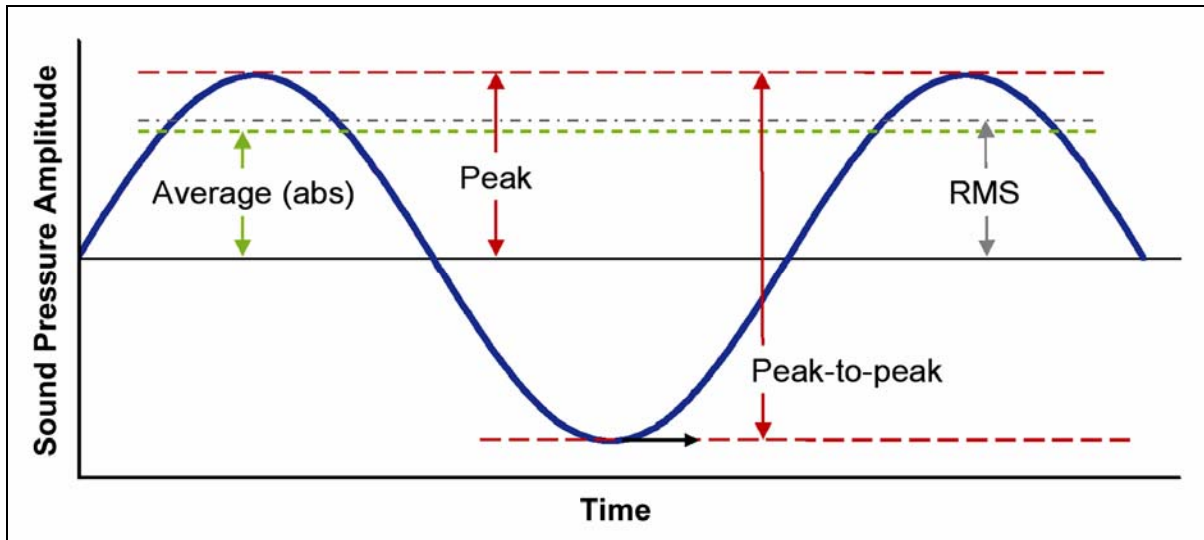


Figure 5. Sound Level Metrics.

In evaluating airborne noise impacts, the method commonly used to quantify environmental sound consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing sensitivity varies with sound frequency. An *audiogram* shows the lowest level of sounds that an animal or human can hear (hearing threshold) at different frequencies (pitch). The y-axis of the audiogram is sound levels expressed in dB (either in-air or in-water) and the x-axis is the frequency of the sound expressed in Hz. Human hearing is less sensitive at low frequencies and higher frequencies than at mid-range frequencies, as shown on Figure 3.1-5. The most common frequency weighting to assess human airborne noise impacts is referred to as A-weighting and the decibel level measured is called the A-weighted sound level (dBA). When evaluating potential impacts on wildlife, this weighting curve is usually not applied, as it is based on human hearing.

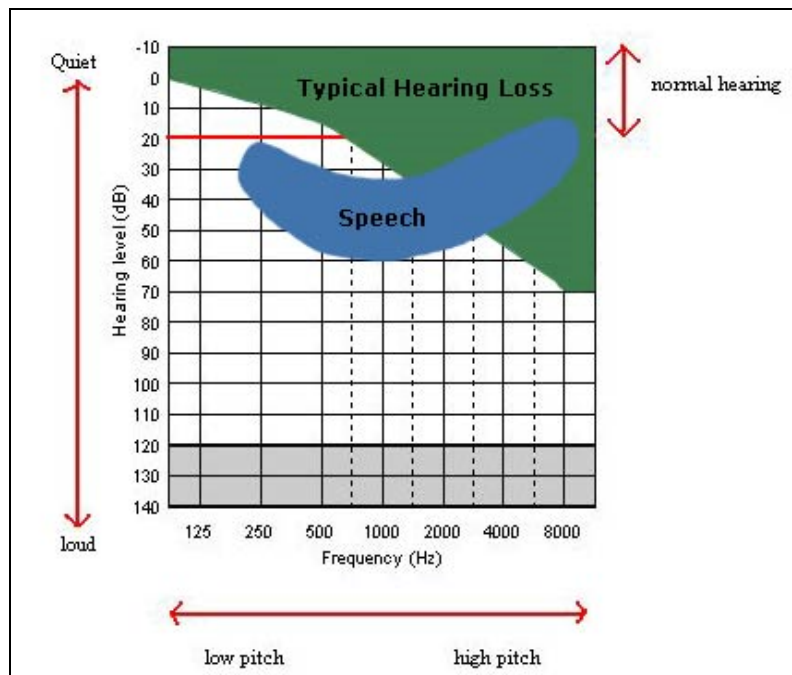


Figure 6. An audiogram of human hearing (Source: Discovery of Sound in the Sea, 2011).

Comparisons of underwater and airborne sound levels are difficult for several reasons, primarily due to the differences in the media (or impedance), and it is important to take into account the reference

pressure level noted previously (1 μPa for underwater, 20 μPa for airborne). Sound pressure level is derived from the equation $\text{SPL} = 20 \log (p/p_{\text{ref}})$, where p is the pressure being measured and p_{ref} is the reference pressure. Thus, 26 dB must be added to the dB level measured in air in order to have the same reference level in water ($20 \log 20$) = 26. Table 3.1-6 shows underwater and airborne sound pressure levels and the relationship with the pressure.

Table 6. Sound Levels of Typical Sources.

Pascals	Underwater sound level (dB re 1 μPa)	Airborne sound level (dB re 20 μPa)	Typical underwater sounds	Typical airborne sounds
1,000,000	240	214	Airgun at 1 m	
100,000	220	194	2 kg high explosive at 100 m	
10,000	200	174		Some military guns at 1 m
1,000	180	154		Sonic booms
100	160	134	Large ship, 100 m	
10	140	114	Fin whale call, 100 m	Discomfort threshold for humans, 500 m from jet takeoff
1	120	94		
0.1	100	74		15 m from auto at 55 km/hr
0.01	80	54	Ambient sound, Sea state 4	Speech in noise at 1 m
0.001	60	34	Ambient sound, Sea state 0	Speech in quiet at 1 m
0.001	40	14		
20 μ	26	0		Human threshold

Notes: dB re 1 Pa = decibels referenced to 1 microPascal

m = meters

km = kilometers

hr = hour

Source: Greene, 1995a

When evaluating acoustic impacts, it is also important to take into account the temporal characteristics of the sound. A sound may be transient in nature (a relatively short duration with an obvious start and stop) or *continuous* (no obvious start or stop). NMFS considers transient sound as *pulsed* and continuous sound as *non-pulsed*. Examples of transient sounds include explosions, airguns, impact pile drivers, and sonar. Examples of continuous sounds include an operating drillship or ship underway. However, it is important to note that that source-path-receiver model discussed below will influence how a sound is perceived by the receiver. For example, sound from a ship underway is continuous at the source, but will not be a continuous to a stationary receiver once it has passed by. Another example is that transient sound such as airguns are impulsive at the source, but due to the many factors that influence propagation, may be perceived as continuous at a farther distance by a receiver. As described in detail in Southall, Bowles, Ellison, et al. (2007), pulses are transient sounds with rapid rise-time and high peak pressures and are potentially injurious to mammalian hearing. Non-pulsed sounds may not result in as much damage, but may still cause behavioral changes.

Ambient noise is the background noise, encompassing all noise sources. Noise sources may include natural and anthropogenic sources near and far. Ambient noise varies with season, location, time of day, and frequency. The ambient noise in an environment will influence how well a receiver may detect a sound source of interest.

Propagation of Sound

Transmission loss underwater is the decrease in acoustic intensity as a sound wave propagates out from a source through *spreading loss*, *reflection*, or *absorption*. Simply, spreading loss refers to the decrease in pressure that results from the increasing surface area a sound wave covers as it moves

further from the source. The sound energy becomes spread over larger areas, so the energy per area, and consequently pressure, decreases. In a uniform medium, sound spreads out from the source in spherical waves – sound levels in this situation typically diminish by 6 dB due to spreading loss when the distance is doubled. Reflection (sound waves “bouncing” off a surface) and refraction (bending of the propagation path) affect sound propagation and can lead to areas of higher or lower sound level than if they were not present. Absorption is the loss of acoustic energy by internal scattering and conversion of pressure energy into heat within the propagation medium. Transmission loss parameters underwater vary with frequency, temperature, sea conditions, source and receiver depth, water chemistry, and bottom composition and topography. Transmission loss parameters in air vary with frequency, air temperature and humidity, wind, turbulence, cloud cover, type of ground cover between source and receiver, and source and receiver height. It is important to note that when comparing different sound levels, attention must be paid to the reference pressure, distance from the source to the receiver, units, and frequencies. For example, sound levels of airguns are often reported as 230-240 dB re 1 μ Pa at 1 m – if the 1 m were omitted from the sound level, it could mean that this was a measured level at some unknown distance, which would mean the actual sound level at the source of the sound would be even higher than 230-240 dB.

Greene (1995a) describes a useful method for considering the process of sound generation, propagation and perception. This method is referred to as the “source-path-receiver” model:

- **Source:** the source of the emitted sound (such as an airgun or drillship). It has particular acoustic characteristics including its pitch and intensity.
- **Path:** the route from source to the receiver of the sound wave. The path may alter the nature of the source sound as it travels from the source to the receiver (terms often used are transmission or propagation). The path can include segments through air or water, or both.
- **Receiver:** the human or animal that perceives the sound after it has left the source and propagated over the path. Receivers have specific detection abilities, so not all receivers will detect or perceive a sound the same way.

As noted previously, this section provides a very basic introduction to acoustic terminology (Greene, 1995a; Au and Hastings, 2008; Harris, 1998). A website with an orientation to sound in the sea is located at: <http://www.dosits.org/>.

Sound can be divided into two subcategories: signal and noise. Signal refers to a sound containing useful or desired information to the receiving entity. Noise refers to sound that is unwanted by the entity that hears it. Thus, any individual sound may be a signal to one entity and be noise to another. In the following sections the terms listener, animal, or receiving entity are interchangeable.

There are many variables that affect sound and how it behaves in the Arctic environment. Properties of sound that influence how far that sound is transmitted, what species hear it, and what physical and behavioral effects it can have include: its intensity, amplitude, frequency, and duration; distance between the sound source and the animal; whether the sound source or the animal is moving or stationary; the level and type of background sound; and the auditory and behavioral sensitivity of the species (Richardson and Malme, 1993; Greene, 1995a).

The definition of sound levels is not directly given by mathematical equations, but depends on a number of factors, like the intensity of the sound wave, the frequency and the length of the sound exposure, and whether the sound is propagating in air or in water (Gausland, 1998). Sound measurements are presented in ratios of pressures, or pressures squared, requiring adoption of a standard reference pressure for use in the denominator of the ratio (Greene, 1995a). Sound pressure level is in microPascals (μ Pa), the frequency of the sound usually is measured in Hertz (Hz), (Gausland, 1998), and intensity levels in decibels (dB) (Greene, 1995a). According to O’Neil, Leary and McCrodan (2010) underwater sound is measured in decibels (dB) relative to a fixed reference pressure of 1 μ Pa. Sound pressure levels (SPL) from impulsive noise sources are commonly

characterized by three acoustic metrics: peak SPL (the maximum instantaneous sound pressure level attained from a pressure pulse), root-mean-square (rms) SPL (the mean square pressure level integrated over a specified time window containing the pressure pulse), and sound exposure level. Sound exposure level (SEL) has units of dB re $1 \mu\text{Pa}^2\cdot\text{s}$ and is a measure of sound exposure (rather than sound pressure) expressed in terms of its equivalent energy dB re $1 \mu\text{Pa}^2/\text{Hz}$. The loudness of any given sound is in all cases a combination of both intensity and frequency (Gausland, 1998).

Sound travels faster and with less attenuation in water than it does in air. Sound propagation varies greatly as a function of sound frequency owing to differential absorption. Low frequencies can travel much further than high frequencies.

Underwater sound essentially is the transmission of energy via compression and refraction of particles in the conducting medium (i.e., in this case, seawater). The pressure pulse from a sound source propagates outward in an expanding spherical shell at approximately 1,500 m/sec ($\sim 4,900$ ft/sec) in seawater. As the shell expands, the energy contained within it is dispersed across an ever-increasing surface area, and the energy-per-unit area decreases in proportion to the square of the distance traveled from the source. However, sound propagation is made vastly more complex as a result of sound interaction with acoustically “hard” boundaries such as the water surface and the sea bottom and “soft” internal features like thermal gradients.

The fate of sound in water can vary greatly, depending on characteristics of the sound itself, characteristics of the location where it is released, characteristics of the environment through which it travels (Greene, 1995b), and the characteristics (e.g., depth, orientation) of the sound receiver (Greene, 1995b; Gausland, 1998). Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998). The likely characteristics or impacts of a given type of sound source in a given location within the Chukchi or Beaufort Sea are based on the characteristics of the marine environment. Bathymetry, sound-source depth, and seabed properties greatly impact the propagation of sound horizontally from the source (Malme, 1995 and references provided therein).

In unbounded seawater (i.e., in the deep oceanic locations, or at close ranges to a source in shallower shelf waters), free field spherical spreading will occur. Once the horizontal propagation path becomes substantially greater than the water depth, a ducted form of spreading tends to occur due to reflections from the seabed and surface. In a duct with perfectly reflective boundaries, the spreading would become cylindrical. In reality, the boundaries, and the seabed in particular, are not perfect reflectors, and there is some loss of energy from the water column as the sound propagates. When impulse sounds propagate in a highly reverberant environment, such as shallow water, the energy becomes spread in time due to the variety of propagation paths of various lengths. The precise rate at which loss will occur is variable and will be site specific, depending on such factors as seabed type.

Measurement of underwater sound levels historically has been complicated by a system of inconsistent and confusing units. Sound pressures in underwater sound studies are reported in terms of peak-peak, 0-peak, rms (root-mean-square), and peak-equivalent rms (Madsen, 2005). The rms is linked to the derivation of amplitude measurements from phase-oscillating signals. The magnitude of sound pressure levels in water normally is described by sound pressure on a logarithmic (decibel: dB) scale relative to a reference rms pressure of $1 \mu\text{Pa}$ (dB re $1 \mu\text{Pa}$) (Madsen, 2005). Different reference units are appropriate for describing different types of acoustic stimuli.

4.1.1.1 Sources of Natural Sound in the Alaskan Arctic

The primary sources of natural ambient sound in the Arctic Ocean include sea ice, wind, waves, marine mammals, and birds. (Richardson and Malme, 1993). The level of natural background or ambient sound varies dramatically between and within seasons at a particular site and varies from site to site because of: (1) variability in components of environmental conditions such as sea ice, temperature, wind, and snow; and (2) the presence of marine life. Burgess and Greene (1999) found

ambient sound in the Beaufort Sea in September 1998 ranged between about 63 and 133 decibels re 1 microPascal @ 1 m (dB re 1 μ Pa, these units are described below).

4.1.1.1.1 Sea Ice

The presence of ice can contribute substantially to ambient sound levels and affects sound propagation. As noted by the National Research Council (NRC, 2001:39), factors such as the "...type and degree of ice cover, whether it is shorefast pack ice, moving pack ice and...floes, or at the marginal ice zone..." can make ambient sound levels louder and more intense. While sea ice can produce substantial amounts of background (ambient) sounds, it also can also function to dampen ambient sound. Areas of water with 100% sea-ice cover can reduce or completely eliminate sounds from waves or surf (Greene, 1995b). As ice forms, especially in very shallow water, the sound propagation properties of the underlying water are affected in a way that can reduce the transmission efficiency of low frequency sound (see Blackwell and Greene, 2002).

Temperature affects the mechanical properties of the ice, and temperature changes can result in cracking. In winter and spring, landfast ice produces substantial thermal cracking sounds (Milne and Ganton, 1964). In areas characterized by a continuous land fast-ice cover, the dominating source of ambient sound is the ice cracking induced by thermal stresses (Milne and Ganton, 1964). The spectrum of cracking ice sounds typically displays a broad range from 100 Hertz (Hz) to 1 Kilohertz (kHz), and the spectrum level has been observed to vary as much as 15 dB within 24 hours due to the diurnal change of air temperature. Urlick (1984 as cited in National Research Council, 2001) reported that variability in air temperature over the course of the day can change received sound levels by 30 dB between 300 and 500 Hz. Ice deformation occurs primarily from wind and currents and usually produces low-frequency sounds. Data are limited, but in at least one instance it has been shown that ice-deformation sounds produced frequencies of 4-200 Hz (Greene, 1981. and Greene 1995b). As icebergs melt, they produce additional background sound as the icebergs tumble and collide.

The Arctic sea ice is undergoing rapid changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general the sea-ice extent is becoming much less in the Arctic summer and slightly less in winter and the decline in sea-ice extent is increasing (Perovich et al., 2010; NSIDC, 2010a). The thickness of Arctic ice is decreasing (Haas et al., 2010; Kwok and Untersteiner, 2011). The distribution of ice is changing, and its age is decreasing (Kwok and Cunningham, 2010). The melt duration is increasing (Markus et al., 2009; Rodrigues, 2009; Wendler, Shukski and Moore, 2010). These factors lead to a decreasing perennial Arctic ice pack. It generally is thought that the Arctic will become ice free in the summer, but at this time there is considerable uncertainty about when that will happen (Stroeve, Maslanik, Serreze, et al., 2011; Tietsche, Notz, Jungclaus, et al., 2011; Zhang, Steele and Schwiger 2010; Overland and Wang, 2010).

The presence of sea ice also affects the timing, nature, and possible locations of human activities such as shipping, research, barging, whale hunting, oil- and gas-related exploration (e.g., seismic surveys and drilling), military activities, and other activities that introduce sound into the marine environment. The presence of ice also impacts which marine species are present, another factor that influences ambient sound levels.

4.1.1.1.2 Wind and Waves

During the open-water season in the Arctic, wind and waves are important sources of ambient sound with levels tending to increase with increased wind and sea state, all other factors being equal (Greene, 1995b). The marginal ice zone, the area near the edge of large sheets of ice, usually is characterized by quite high levels of ambient sound compared to other areas, in large part due to the impact of waves against the ices edge and the breaking up and rafting of ice floes (Milne and Ganton, 1964).

4.1.1.1.3 Marine Mammals and Birds

At least seasonally, marine mammals can contribute to the background sounds in the acoustic environment of the Beaufort and Chukchi Seas. Frequencies and levels are highly dependent on seasons and the mix of species present and vocalizing. For example, source levels of bearded seal songs have been estimated to be up to 178 dB re 1 μ Pa at 1 m (Ray et al. 1969; Stirling et al. 1983; and Cummings et al., 1983; Thomson and Richardson, 1995a). Ringed seal calls have a source level of 95-130 dB re 1 μ Pa at 1 m, with the dominant frequency under 5 kHz (Stirling et al. 1973; Cummings et al., 1984 in Thomson and Richardson, 1995a). Bowhead whales, which are present in the Arctic region from early spring to mid to late fall, produce sounds with estimated source levels ranging from 128-189 dB re 1 μ Pa at 1 m in frequency ranges from 20-3,500 Hz. Thomson and Richardson (1995a) summarized that most bowhead whale calls are “tonal frequency-modulated” sounds at 50-400 Hz. There are many other species of marine mammals in the Arctic marine environment whose vocalizations contribute to ambient sound including, but not limited to, the gray whale, walrus, ringed seal, beluga whale, spotted seal, fin whale (in the southwestern areas), and the humpback whale. Walrus, seals, and seabirds (especially near breeding colonies) all produce sound that can be heard above water.

4.1.1.2 Sources of Anthropogenic Sound

Levels of anthropogenic (human-caused) sound can vary dramatically depending on the season, type of activity, and local conditions. Sources of anthropogenic sounds in the Beaufort and Chukchi seas include vessels and aircraft, scientific and military equipment, oil and gas exploration and development, and human settlements.

Sound from Vessels

Shipping sounds, also called ship noise, are often at source levels of 150-190 dB re 1 μ Pa, have since 1950, contributed 10- to 20-dB increase in the background sound levels in the sea (Andrew, Howe, Mercer et al., 2002; Acoustic Ecology Institute, 2005; McDonald et al., 2006). The types of vessels in the Beaufort and Chukchi Seas typically include barges, skiffs with outboard motors, icebreakers, tourism and scientific research vessels, and vessels associated with oil and gas exploration, development, and production. In the Beaufort and Chukchi Seas, vessel traffic and associated noise presently is limited primarily to late spring, through December.

Shipping traffic is mostly significant at frequencies from 20-300 Hz (Greene, 1995b). Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contributes to overall ambient noise levels in some regions of the Arctic. The use of aluminum skiffs with outboard motors during fall subsistence whaling and fishing in the Alaskan Arctic also generates noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Greene, 1995b). In shallow water, vessels more than 10 km (6.2 mi) away from a receiver generally contribute only to background-sound levels (Greene and Moore, 1995).

During the open-water season, vessels such as tugs, self-propelled barges, and crew boats are the main contributors to Northstar-associated underwater sound levels, with broadband sounds from such vessels often detectable approximately 30 km (19 mi) offshore. In 2002, sound levels were up to 128 dB re 1 μ Pa at 3.7 km (2.3 mi) when crew boats or other operating vessels were present (Richardson and Williams, 2003).

Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce louder, but also more variable, sounds than those associated with other vessels of similar power and size (Greene and Moore, 1995). When an ice-management vessel is transiting open water, the sound generated is less than when the vessel is managing or breaking ice. The greatest sound generated during ice-breaking operations is produced by cavitations of the propeller as opposed to the engines or the ice on the hull; extremely variable increases in broad-band (10-10,000 Hz) noise levels

of 5-10 dB are caused by propeller cavitation (Greene and Moore, 1995). Greene and Moore (1995) reported estimated source levels for icebreakers to range from 177-191 db re 1 μ Pa-m. Based on measurements in Greene (1987b), sounds produced by an icebreaker, the *Robert Lemeur*, actively managing ice in the Beaufort Sea were estimated to fall below 160 dB rms at <100 m from the vessel and to fall below 120 dB rms at ~8 km from the vessel. Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (3 mi) (Greene and Moore, 1995). In some instances, icebreaking sounds are detectable from more than 50 m (31 mi) away. In general, spectra of icebreaker noise are wide and highly variable over time (Greene and Moore, 1995).

During icebreaking, extremely variable increases in broad-band (10-10,000 Hz) noise levels of 5-10 dB are caused by propeller cavitation. Greene and Moore (1995) reported estimated source levels for icebreakers to range from 177-191 db re 1 μ Pa-m.

Sound from Oil and Gas Activities

Sound from oil and gas exploration and development activities include seismic surveys, development construction (pipelines, platforms, etc.), drilling, and production activities.

Seismic Surveys

The oil and gas industry in Alaska conducts marine (open-water) surveys in the summer and fall and on-ice and in-ice seismic surveys in the winter to locate geological prospects potentially capable of containing petroleum accumulations and to better characterize ocean substrates or subsea terrain. The OCS leaseholders also conduct low-energy, high-resolution geophysical surveys to evaluate geohazards, biological communities, and archaeological resources on their leases.

2D seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960s and early 1970s, resulting in extensive coverage over the area. Seismic surveys vary, but a typical 2D/3D seismic survey with multiple guns would emit sound waves at about 10-120 Hz, and pulses can produce frequencies up to 500-1,000 Hz (Greene and Moore, 1995). Seismic airgun noise pulses are directed towards the ocean bottom, but can propagate horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994 in Greene and Moore, 1995). Early acoustic studies in the Arctic documented the long range propagation of sound generated by dynamite shots, to distances up to 1150 km across the Arctic Basin. These studies were conducted from ice islands in a largely ice-covered sea (Kutschale, 1961; Marsh and Mellon, 1963; Hunkins and Kutshale, 1963). Analysis of sound associated with seismic operations in the Beaufort Sea and central Arctic Ocean during ice-free conditions also documented propagation distances up to 1300 km (Thode, Greene, and Roth, 2010; Richardson, 1998, 1999). While seismic energy does have the capability of propagating for long distances it generally decreases to a level at or below the ambient noise level at a distance of 10 km from the source (Richardson, 1998, 1999; Thode, Greene, and Roth, 2010).

Greene and Moore (1995) summarized that typical signals associated with vibroseis sound source used for on-ice seismic survey sweep from 10-70 Hz, but harmonics extend to about 1.5 kHz. In-ice seismic activities have airgun signals that are similar to open-water surveys.

Sound from Drilling and Production Activities.

Onshore, offshore, and island-based exploration and production facilities use machinery and equipment that produce sounds, which can be transmitted into the marine environment.

Measurements of sounds from the drillship, *Northern Explorer II* (formerly *Canmar Explorer II*), were performed at two different times and locations in the Beaufort Sea (Miles, Malme and Richardson, 1987; Greene, 1987b). During acoustic data collection, there was a support vessel idling in the vicinity of the drill rig (Miles, Malme and Richardson, 1987; Greene, 1987b). Using the data for Northern Explorer II, in 2007, JASCO modeled sound-level radii for a comparable drill ship at two locations in the Beaufort Sea. Modeled sound-level radii indicate that the sound would not

exceed the 180 dB. The ≥ 160 -dB radius for the drillship was modeled to be 172 ft (52.5 m); the ≥ 120 -dB radius was modeled to be 4.6 mi (7.4 km). The area estimated to be exposed to ≥ 160 dB at the modeled drill sites would be $\sim 0.01 \text{ km}^2$ (0.004 mi^2).

The ice-strengthened *Kulluk*, a floating platform specially-designed for Arctic waters, was used for drilling operations at the Kuvlum drilling site in western Camden Bay in 1992 and 1993. Data from the *Kulluk* indicated broadband source levels (20-10,000 Hz) during drilling were estimated to be 191 and 179 dB re μPa at 1 m, respectively, based on measurements at a water depth of 20 m in water about 30 m deep (Greene and Moore, 1995).

There currently are no oil-production facilities in the Chukchi Sea. In State waters of the Beaufort Sea, there are three operating oil-production facility on artificial islands (Northstar, Ooguruk, and Nikaitchuq) and two production facilities on a man-made peninsulas/causeways (Endicott and Liberty).

Sounds originating from drilling activities on islands can reach the marine environment. Greene and Moore (1995) reported noise typically propagates poorly from artificial islands, because it must pass through gravel into the water. Greene and Moore (1995) reported that during unusually quiet periods, drilling noise from ice-bound islands would be audible at a range of about 10 km ($\sim 6.2 \text{ mi}$), when the usual audible range would be $\sim 2 \text{ km}$ ($\sim 1.2 \text{ mi}$). Greene and Moore (1995) also reported that broadband noise decayed to ambient levels within $\sim 1.5 \text{ km}$ ($\sim 0.9 \text{ mi}$), and low-frequency tones were measurable to $\sim 9.5 \text{ km}$ ($\sim 5.9 \text{ mi}$) under low ambient-noise conditions, but were essentially undetectable beyond $\sim 1.5 \text{ km}$ ($\sim 0.9 \text{ mi}$) with high ambient noise. Much of the production noise from oil and gas operations on gravel islands is substantially attenuated within 4 km (2.5 mi) and often not detectable beyond 9.3 km (5.8 mi) away.

Blackwell and Greene (2006) found Northstar Island sound levels showed more variation (lower min, higher max) during construction than during drilling and production. Without vessel noises, they detected underwater broadband island sounds in the sound field that reached background values at 2–4 km. In-air broadband measurements were not affected by the presence of vessels and reached background values 1–4 km from Northstar (Blackwell and Greene, 2006).

Sound from Aircraft

The level and duration of sound received underwater from aircraft depends on altitude and water depth. Received sound level decreases with increasing altitude. For a helicopter operating at an altitude of 1,000 ft (305 m), there were no measured sound levels at a water depth of 121 ft (37 m) (Richardson et al., 1989, citing Greene, 1985).

Miscellaneous Sound Sources

Other acoustic systems that may be used in the Arctic by researchers, military personnel, or commercial vessel operators, include: high-resolution geophysical equipment (see Section 2.2.3.1 Ancillary Activities); acoustic Doppler current profilers; mid-frequency sonar systems; and navigational acoustic pingers (LGL, Ltd. 2005 and 2006). These active sonar systems emit transient, and at times, intense sounds that vary widely in intensity and frequency.

4.2 Pollution and Contaminants

Contaminants may be naturally occurring in the Arctic (e.g., mercury, lead, cadmium, oil seeps) or they may be pollutants transported from more industrialized areas by wind and ocean currents. Man made chemicals such as organochlorine pesticides and flame retardant chemical are transported to the Arctic. Radionuclides have been transported from Russia to the Alaskan Arctic by wind. Increases in shipping also increase the potential for petroleum spills or spills of other chemicals from tankers or ships transporting chemicals as freight. For more background on pollution in the Arctic, see the Arctic Monitoring and Assessment Programme (AMAP) Reports (1998, 2002, 2004, and 2006).

Alaskan marine mammals may carry contaminants such as PCBs, DDT, hexachlorocyclohexanes (HCHs), HCB, dieldrin, mirex, chlordane, and toxaphene; contaminants such as these are found throughout the world, including the pinnipeds, and the bowhead whale (Becker, Mackey, Schantz, et al., 1995). Becker, Mackey, Schantz, et al. (1995) indicate these are lipophilic and the highest levels are found in the blubber. Other contaminants which may be found in the Arctic include POPs, metals, anthropogenically produced chemicals and petroleum products.

Cooper et al. (2000) analyzed anthropogenic radioisotopes in the epidermis, blubber, muscle, kidney, and liver of marine mammals harvested for subsistence food in northern Alaska and in the Resolute, Canada region. The majority of samples analyzed had detectable levels of caesium-137 (^{137}Cs). Among tissues of all species of marine mammals analyzed, ^{137}Cs was almost always undetectable in the blubber and substantially higher in epidermis and muscle tissue than in the liver and kidney tissue. The levels of anthropogenic radioisotopes measured were orders of magnitude below levels that would merit public health concern. The study noted there were no obvious geographical differences in ^{137}Cs levels between marine mammals harvested in Resolute, Canada and those from Alaska.

4.3 Marine Vessel-Traffic

Threats to marine mammals and birds from marine vessel traffic include disturbance and ship strikes. Shipping and vessel traffic is expected to increase in the Arctic as warming continues and the ice free season lengthens. Noise associated with ships or other boats could cause marine mammals or birds to alter their movement patterns or make other changes in habitat use. Discharges such as ballast water, grey water, or deck wash from marine vessel traffic (especially from large vessels such as cruise ships) could cause degradation of the marine environment through introduction of parasites, introduction of invasive species, introduction of pathogens, and could increase the risk of exposure to contaminants and disease vectors. The infrequency of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with marine mammals is low, but birds are more susceptible to ship strikes, particularly at night and in near shore waters.

Large ships that are active in the project area have the potential to cause noise and disturbance, potentially altering movement patterns or disrupting foraging or resting behavior of marine mammals and birds. These include oil and gas industry vessels, research ships, icebreakers, cruise ships, barges and cargo ships.

4.3.1 Research Activities

Research activities appear to be increasing in the Arctic. A sizable scientific research effort conducted by governmental, non-governmental and educational organizations operating from marine vessels and aircraft occurs every year in the Beaufort and Chukchi seas. The programs conducted by these organizations are expected to continue through the period of the proposed action. Marine environmental baseline studies include deployment of oceanographic equipment for collecting water and sediment samples, and use of nets and trawls for collection of phytoplankton, zooplankton, benthic invertebrates, pelagic invertebrates, and fish sampling. Also continuing will be observations of marine and coastal birds and marine mammals using standardized survey transect methods and passive acoustic monitoring. Metocean buoy and acoustic wave and current meters will continue to be deployed for studies of physical oceanography and climate studies.

Ongoing activities in the Beaufort and Chukchi sea regions also include the multinational efforts carried out by the Pacific Arctic Group (PAG). The PAG is a group of institutes having a Pacific perspective on Arctic science. Organized under the International Arctic Science Committee (IASC), the PAG mission is to serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest to the Arctic region. Focus is on four geographical research areas within the Bering Sea, Bering Strait, Chukchi Sea, and Beaufort Sea. Some, but not all, of these activities could coincide in time and space with the proposed exploration plan activities.

An example of the work being done by PAG is the Diversified Biological Observatory, a cooperative effort of the USA, Canada, Russia, Japan, China, and Korea. Participants contribute all data collected from research vessels (primarily icebreakers) from past, ongoing, and planned research programs. The scientific work includes synthesis of multi-disciplinary studies including physical oceanography, marine chemistry, biological oceanography, marine biology (primary productivity, zooplankton, phytoplankton, ice algae, epontic, pelagic, and benthic collections), marine mammal and bird observations, and tagging studies (<http://pag.arcticportal.org/>).

4.3.2 Oil and Gas Exploration Activities

Offshore petroleum exploration, development, and production activities have been conducted in Alaska State waters or on the Alaska OCS in the Beaufort and Chukchi seas as a result of previous lease sales since 1979. Extensive 2D seismic surveying has occurred in both program areas (see Section 4.1 - Acoustic Environment). The MMS-permitted seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960's and early 1970's. Much more seismic activity has occurred in the Beaufort Sea OCS than in the Chukchi Sea OCS. The 2D marine seismic surveys in the Beaufort Sea began with two exploration geophysical permits issued in 1968 and 4 in 1969. Both over-ice (29 permits) and marine 2D (43 permits) seismic surveys were conducted in the 1970's. With one exception, all 80 marine and 43 over-ice surveys permitted in the Beaufort Sea OCS by MMS in the 1980's were 2D. In the Beaufort Sea, 23 MMS G&G permits were issued in 1982 (11 marine and 12 over-ice 2D surveys) and 24 MMS G&G permits were issued in 1983 (1, 3D over-ice survey; 14, 2D over-ice surveys; and, 9, 2D marine surveys). The first 3-D on-ice survey occurred in the Beaufort Sea OCS in 1983. In the 1990's, both 2D (2 on-ice and 21 marine) and 3D (11 over-ice and 7 marine OBC) seismic surveys were conducted in the Beaufort Sea. The first marine 3D seismic survey in the Beaufort Sea OCS occurred in 1996.

Thirty exploratory wells have been drilled in the Federal Beaufort over a 20+ year period between 1981 and 2002. This drilling occurred from a variety of drilling platforms (e.g., gravel islands, single steel drilling caisson, drillships, etc.) and, during different seasons of the year, including the open water period. The last exploration well drilled in the Beaufort Sea OCS was drilled in the winter of 2002-2003 at the McCovey prospect.

Compared to the North Slope/Beaufort Sea, there has been little oil- and gas-related activity in the Chukchi Sea. Five exploratory wells have been drilled in the Chukchi Sea from past lease sales, all using drillships. These wells were drilled between 1989 and 1991, inclusive. The last Chukchi Sea well was drilled in 1991 at the Diamond Prospect. There is no existing OCS offshore development or production in the Chukchi Sea. Outer Continental Shelf Lease Sale 193 (Chukchi Sea OCS planning area) was held on February 6, 2008. Sale 193 offered approximately 12 million acres for leasing, and bids were received for over 1,100,000 acres.

Many offshore activities also require ice management (icebreaking), helicopter traffic, fixed wing monitoring, other support vessels, and, in some cases stand-by barges.

Data on past drilling in both federal and state waters is relatively complete, especially since 1990. Data on other activities, such as hunting activity, barge traffic, scientific research, military traffic, tourism, and shipping are more difficult to quantify.

4.4 Climate Change

Within the scientific community there is widespread consensus that atmospheric temperatures on earth have been increasing (warming). The Arctic marine environment has shown changes over the past several decades, and these changes are part of a broader global warming that exceeds the range of natural variability over the past 1000 years (Walsh, 2008). The changes have been sufficiently large in some areas of the marine Arctic (e.g., the Bering Sea and Chukchi Sea) that consequences for marine ecosystems appear to be underway (Walsh, 2008). The proximate effects of climate change in

the Arctic are being expressed as increased average winter and spring temperatures and changes in precipitation amount, timing, and type (Serreze et al., 2000). Increases of approximately 75 days or more days in the number of days with open water in parts of the present-day season sea ice zone occur north of the Bering Strait in the Beaufort, Chukchi, and East Siberian Seas; and increases by 0-50 days elsewhere in the Arctic Ocean have been seen (Walsh, 2008). In addition, landfast ice is forming one month later in the Chukchi Sea and is breaking up three weeks earlier in the Beaufort Sea (Mahoney, Eicken, Gaylord, et al., 2007). These changes, in turn, result in physical changes such as reduced sea ice, increased coastal erosion, and changes in hydrology, depth to permafrost, and carbon availability (ACIA, 2005).

The Intergovernmental Panel on Climate Change (IPCC) concluded in its synthesis report (IPCC 2007a), as part of its Fourth Assessment Report (IPCC 2007b), that:

- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.
- Global greenhouse gas emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004.
- Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.

A general summary of the changes attributed to the current trends of Arctic warming indicate sea ice in the Arctic is undergoing rapid changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general, the sea-ice extent is becoming much less in the Arctic summer and slightly less in winter. The thickness of Arctic ice is decreasing. The distribution of ice is changing, and its age is decreasing. The melt duration is increasing. These factors lead to a decreasing perennial Arctic ice pack.

Satellite data have shown that Arctic March sea-ice extent has decreased by about 2.7% per decade during the period 1979 through 2010 (Perovich, Meier, Maslanik, et al., 2010). This decreasing trend is observed in all seasons, but the greatest decrease is found in September with a trend of -11.5% per decade (Figure 7; NSIDC, 2011b). As of September 15, 2011 a preliminary ice extent estimate indicated the 2011 minimum was the second lowest year for ice extent following 2007 (NSIDC, 2011a). Different sensors have resulted in at least one group calling the 2011 minimum the lowest. From 2007-2011, the lowest ice extents since the satellite record began in 1979, have been recorded (NSIDC, 2011b). In September 2007, Arctic sea-ice extent reached its lowest value since satellite measurements began in 1979, and was 23% lower than the previous record established in 2005 (NSIDC, 2007). While changes in the reduction of summer sea-ice extent are apparent, the cause(s) of change are not fully established. The evidence suggests that it may be a combination of oceanic and atmospheric conditions that are causing the change. Incremental solar heating and ocean heat flux, longwave radiation fluxes, changes in surface circulation, and less multiyear sea ice all may play a role (Overland and Wang, 2010; Woodgate, Weingartner, and Lindsay, 2010; Polyakov, Timokhov, Alexeev, et al., 2010; Comiso, 2011).

Sea-ice extent predictions, using several climate models and taking the mean of all the models, estimate that the Arctic will be ice free during summer in the later part of the 21st century (IPCC, 2007). There is considerable uncertainty in the estimates of summer sea ice in these climate models, with some predicting 40–60% summer ice loss by the middle of the 21st century (Holland, Bitz and Tremblay, 2007). Using a suite of models, a 40% loss is estimated for the Beaufort and Chukchi seas (Overland and Wang, 2007). Using a subset of climate GCMs Douglas (2010) estimates the Chukchi will be ice free for up to 3 months by mid century. Some investigators, citing the current rate of decline of the summer sea-ice extent, believe it may be sooner than predicted by the models and may be as soon as 2013 (Stroeve, Serreze, Drobot, et al., 2008). Other investigators suggest that variability at the local and regional level is very important for making estimates of future changes. Generally, it

is thought that the Arctic will become ice free in the summer, but at this time there is considerable uncertainty about when that will happen (Stroeve, Maslanik, Serreze et al., 2011; Tietsche, Notz, Jungclaus et al., 2011; Zhang, Steele and Schwiger, 2010; Overland and Wang, 2010).

Much research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA, 2005). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice.

Figure 7 (below) illustrates the change in sea-ice coverage of the Arctic between 1979 and 2011. The

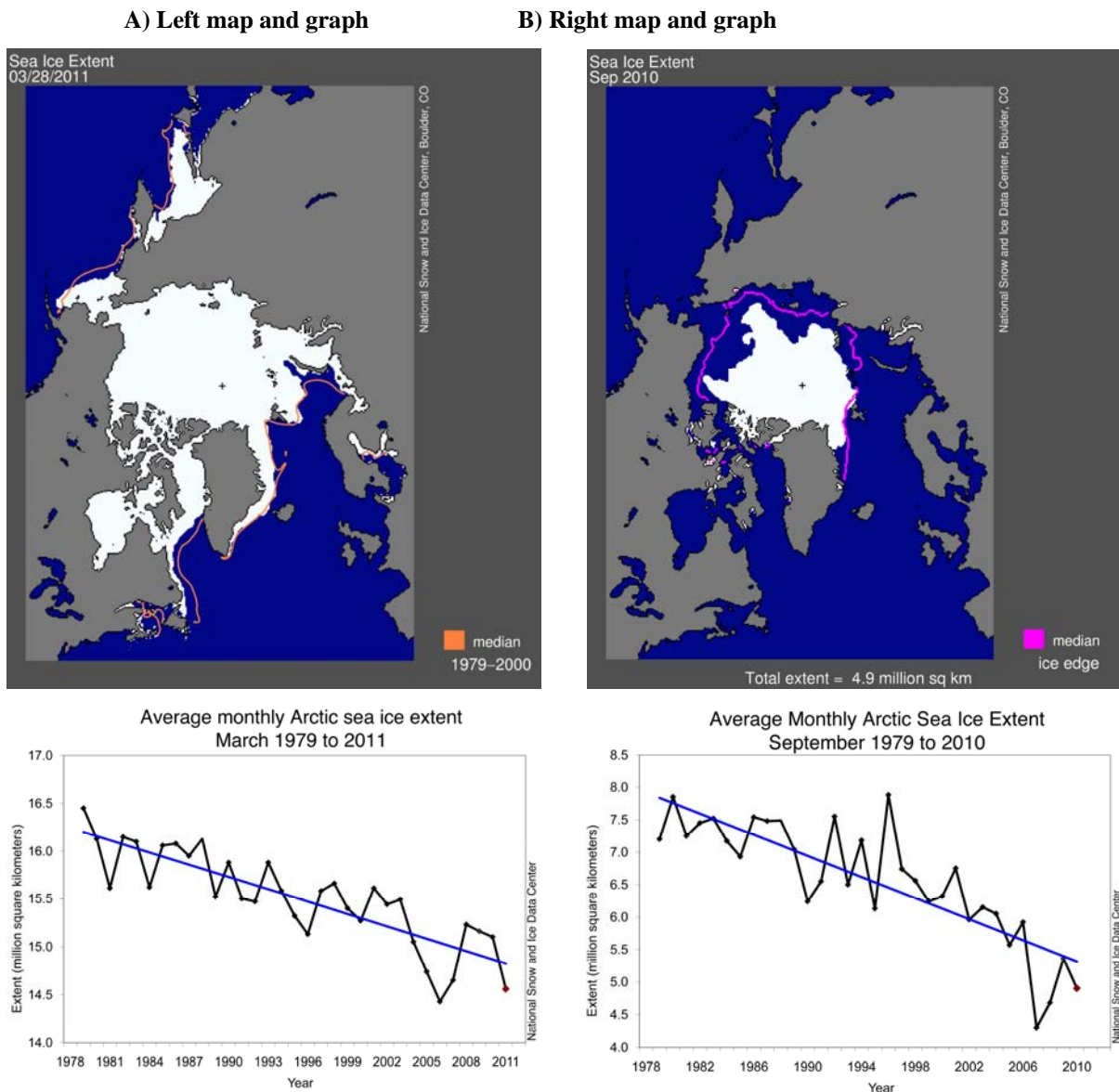


Figure 7. Change in Arctic Sea-ice Extent between 1979 and 2011 (NSIDC, 2011a, 2011b).

left side map (A) shows the maximum sea-ice extent (in white) for March 2011 and the median sea-ice extent (red line) for the period 1979–2000. The left side graph shows the average monthly sea-ice

extent over the period 1979–2011. The right side map (B) shows the minimum sea-ice extent (in white) for September 2010 and the median sea-ice extent (red line) for the period 1979–2010. The right side graph shows the average monthly sea-ice extent over the period 1979–2010 (NSIDC, 2011a, b).

5. EFFECTS OF THE PROPOSED ACTION

In this section, BOEMRE determines the anticipated effect of the Proposed Action on listed species under the jurisdiction of the FWS. The species list for this consultation includes the polar bear (*Ursus maritimus*), spectacled eider (*Somateria fischeri*), and Steller's eider (*Polysticta stelleri*). All three species are listed as threatened under the ESA. In addition, the following species are candidate species: the Kittlitz's murrelet (*Brachyrampus brevirostris*) and the yellow-billed loon (*Gavia adamsii*). BOEMRE included these species because they may be proposed for listing or be listed in the foreseeable future. BOEMRE collectively refers to these species as "listed species." BOEMRE concludes each species section with an ESA determination.

Our Proposed Action is to continue to authorize oil and gas leasing, exploration, and development and production activities on the Alaskan Arctic OCS consistent with previous 5-year oil and gas leasing programs (Figure 1). BOEMRE has divided the discussion of effects into three sections: (1) Overall Approach to Analysis, (2) Exploration, and (3) Development and Production. These reflect the incremental analysis of the consequences of the phases of oil and gas activities with emphasis for this document on the exploration phase and addressing the more speculative later phase of development and production in more general terms to allow FWS, in generating a Biological Opinion, to assess the potential for the Proposed Action to jeopardize listed species.

At this time industry holds leases on 487 lease blocks from previous lease sales in the Chukchi Sea and 183 lease blocks from previous lease sales in the Beaufort Sea (Table A and Figure A). Of these, three blocks are producing oil (BP Alaska Inc.'s Northstar project) and two blocks are in development (BP Alaska Inc.'s Liberty project).

Note: Oil spills consistently receive agency and public interest. For this Biological Evaluation BOEMRE includes the evaluations of different sized spills from previously completed NEPA documents. These analyses are readily available from other sources. Because it should not matter to the potentially affected resource where the oil contacting them comes from, a spill described during an exploration or development and production phase is immaterial as the effect on the resource would be the same. Accordingly, the analyses for large and very large oil spills (VLOS) come from National Environmental Policy Act documents indicated in Table 7 (see also Appendix A).

Table 7. Sources of large and very large spill analyses in the Chukchi Sea and Beaufort Sea.

Spill Size		Planning Area	
		Chukchi Sea	Beaufort Sea
Large Spill	Exploration		
	Production	LS 193 EIS ¹	Beaufort Sea Multi-sale EIS ²
Very Large Spill	Exploration	LS 193 SEIS ³	
	Production		Beaufort Sea Multi-sale EIS

Sources: ¹USDOI, MMS, 2007
²USDOI, MMS, 2003
³USDOI, BOEMRE, 2011

5.1 Overall Approach to Analysis

The Proposed Action is based on the exploration and development scenarios presented in Chapter 2. BOEMRE is providing FWS with our best estimates about what level and kinds of exploration (particularly seismic surveys and drilling) may occur. BOEMRE is also providing best estimates regarding development and production that may occur if sufficient quantities of oil are discovered as a result of exploration. BOEMRE also describes typical mitigating measures that could avoid or reduce the potential for adverse effects. BOEMRE will reinitiate consultation with FWS for any future Development and Production Plan (DPP).

Scope of the Analysis

For ESA consultation on the Proposed Action, BOEMRE specifically requests incremental Section 7 consultation. Regulations at 50 CFR 402.14 (k) allow consultation on part of the entire action as long as that step does not violate Section 7(a)(2); there is a reasonable likelihood that the entire action will not violate Section 7(a)(2); and the agency continues consultation with respect to the entire action, obtaining a biological opinion for each step. Accordingly, BOEMRE consults on the early lease activities (seismic surveying, ancillary activities, and exploration drilling) to ensure that activities under any leases issued will not result in jeopardy to a listed species or cause adverse modification of designated critical habitat. BOEMRE is required to re-consult for any proposed development and production activities.

The predecessor agency to BOEMRE—MMS (Minerals Management Service)—prepared Biological Evaluations (BEs) that evaluated most activities contemplated under the Proposed Action. In response to MMS requests to initiate formal consultation, FWS returned a Biological Opinion analyzing potential oil and gas exploration, development, and production activities in the Alaska Arctic OCS. This BE entirely supersedes previous BOEMRE consultation documents and those consultations are not incorporated by reference.

We determined the scope of the Proposed Action includes leasing, exploration, development and production, other human activities, and environmental trends on the Alaska North Slope and adjacent offshore areas over the life of the Proposed Action. BOEMRE weighed more heavily those activities that were more certain and closer in time. Activities further away in time or farther from the action area were considered more speculative.

There are multiple ways in which listed species could be impacted by exploration and development/production activities in the Arctic Region OCS. This evaluation will primarily evaluate the proposed exploration activities and consider the later more speculative phases of development and production more generally, but in enough detail to provide FWS with information to determine whether or not the entire potential action would jeopardize the continued existence of listed species.

Effects from BOEMRE research activities or conservation programs are not considered under this BE.

Key Considerations

The effects analysis considers the following important considerations in determining the anticipated effects from the Proposed Action.

Timing. Activities can occur at different times of the year. For example, most exploration activity occurs during the open-water period; but in-ice seismic surveys may occur during late fall/early winter when new ice is forming. Nearshore on-ice seismic operations occur in late winter/early spring in the Beaufort Sea. Seismic activities are typically restricted from entering the Chukchi Sea to protect the spring lead systems until after July 1.

Production operations could take place year-round and facilities may remain over several decades.

Residence Time and Periodicity. Effects can vary based on the duration, frequency and intensity of exposure to certain activities in an area during one or more seasons. Effects can be short- or long-term. For example, seismic operations may occur over 60–90 days, and over hundreds of miles. Similarly, production facilities may have a relatively small footprint, but may remain operating over several decades.

Spatial Extent. The planning areas are large, and areas explored in any given season vary widely from survey to survey. Beyond the footprint of a seismic vessel or on-ice operations, drill rigs, or other facilities, consideration must be given to the area affected by noise, support-vessel or aircraft traffic. Existing leases are scattered across the Arctic Region OCS (Figure 1).

Environmental Factors. Weather, currents, wind, and other environmental variables could influence the intensity or magnitude of potential effects.

Biological Principles/Factors. Each species may have sensitive population components (e.g., females with young), key habitats (e.g., denning areas, the spring polynya system, breeding and birthing habitats) or specific behavioral responses to certain activities.

Best Available Information. BOEMRE uses the best available scientific information to conduct this biological evaluation. The primary source of our information is published, peer-reviewed journal articles or reference texts. Agency technical or survey reports may be the best available information in some cases. On occasion, the best available information could come from unpublished reports by agency personnel, industry, or conservation groups. Anecdotal information or personal communications are used infrequently.

Use of Mitigation Measures. Monitoring and mitigating measures similar to those typically required in the most recent LOAs issued by FWS related to protection of marine mammals in the Arctic Region during oil and gas activities would be in place unless FWS, through the process of this consultation, or through the issuance of an LOA, concludes that such measures do not afford sufficient protection to marine mammals or if FWS requires other measures instead (see Section 2.3 Mitigation Measures).

Impact Producing Factors

The primary impact-producing-factors associated with exploration activities are vessel traffic, aircraft traffic, seismic surveys, drilling operations, and discharges.

The primary impact-producing-factors associated with the Development and Production stage are vessel traffic, aircraft traffic, facility construction, drilling operations, facility operations, and discharges.

Emissions associated with typical exploration activities were evaluated by the Environmental Protection Agency (EPA) in 2011. Emissions from exploration vessels, particularly drillships, were determined not to adversely affect listed species. The EPA analysis indicated there would be little opportunity for marine mammals to be exposed to emissions. The full EPA analysis is included as Appendix B and this impact –producing factor is not considered further in this Biological Evaluation.

5.2 Background on Effects

The following sections describe the potential adverse effects of vessel traffic, aircraft traffic, seismic surveys, drilling operations, and discharges associated with the Proposed Action on listed species.

One of the greatest concerns associated with the impacts of oil and gas exploration and development on marine mammals has to do with the impacts of noise. Human-caused noise is transmitted through the air and through marine waters from a variety of activities during OCS oil and gas exploration and development/production. These activities include, but are not limited to: 2D/3D seismic surveys; pipeline, platform, and related shore based facility construction; drilling; production; platform abandonment; icebreaker and other ship, boat, and barge transit; high-resolution seismic surveys; and aircraft traffic.

5.2.1 Background on Effects of Underwater Noise on Listed Species

The effects of underwater sound on marine mammals can be divided into physiological and behavioral effects. Physiological effects include damage to hearing or prolonged stress reactions. Behavioral effects include communication and masking effects or displacement from foraging or resting habitats. Either effect may have long-term consequences (Richardson, 1995b).

Hearing for marine mammals is important because they rely on sound to communicate, find mates, navigate, orient, detect predators or prey, and gain other information about their environment. There

is concern about the impacts of anthropogenic noise on marine mammals with respect to their ability to maintain normal life functions (NRC, 2003, 2005; Southall, Bowles, Ellison et al., 2007).

Results from several experimental studies have been published regarding sound-exposure metrics incorporating sound-pressure level and exposure duration. Investigators have examined noise-induced TTS in some odontocetes and pinnipeds exposed to moderate levels of underwater sound of various band widths and durations (Nachtigall et al., 2004; Kastak et al., 1999; Schlundt et al., 2000; Finneran et al., 2002). Kastak et al. (2005) summarized that:

Because exposure to...noise in the marine environment is sporadic and interrupted, it is necessary to examine variables associated with varying noise sound pressure levels, intermittence of exposure, and total acoustic energy of exposure, in order to accurately predict the effects of noise on marine mammal hearing.

The NRC developed a conceptual approach of injury and behavioral “take equivalents”. These take equivalents use a severity index that estimates the fraction of a take experienced by an individual animal. The severity index would be higher if the activity could be causing harassment at a critical location (e.g., calving habitat) or during a critical time or life function (e.g., breeding, calving). Mitigation measures are specifically designed to reduce the potential for takes, particularly during those times or in areas that could be more important than others.

Available evidence indicates that reactions to sound, even within a species, may depend on the listener’s sex and reproductive status, possibly age and/or accumulated hearing damage, habituation, type of activity engaged in at the time or, in some cases group size (Schusterman, 1981; Richardson, 1995a and 1995b). For example, reactions to sound may vary, depending on whether females have calves accompanying them or whether individuals are feeding or migrating. It may depend on whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates the ability, in a given situation, to predict the impacts of sound on a species or on classes of individuals within a species.

5.2.1.1 Physiological Effects

Ketten (1998) reported that hearing loss can be caused by exposure to sound that exceeds an ear’s tolerance (i.e., exhaustion or overextension of one or more ear components). Hearing loss to a marine mammal could result in an inability to communicate effectively with other members of its species, or detect approaching predators or vessels.

Hearing loss resulting from exposure to sound often is referred to as a threshold shift. Some studies have shown that following exposure to a sufficiently intense sound, marine mammals may exhibit an increased hearing threshold after the sound has ceased (Nachtigall et al., 2004; Kastak et al., 1999; Schlundt et al., 2000; Finneran et al., 2002). Thus, a threshold shift indicates that the sound exposure resulted in hearing loss causing decreased sensitivity. This type of hearing loss can be a temporary threshold shift (TTS) if the individual recovers its pre-exposure sensitivity of hearing over time, or a permanent threshold shift (PTS) if it does not.

Ketten (1998) reported that whether or not a TTS or a PTS occurs will be determined primarily based on the extent of inner ear damage that the received sound level causes. In general, whether a given species will tend to be damaged by a given sound depends on the frequency-sensitivity of the species. Loss of sensitivity is centered on the peak spectra of the sound causing the damage.

Long-lasting impairment of hearing ability could impair the ability of the affected marine mammal to hear important communication signals or to interpret auditory signals.

Most experiments have looked at the characteristics (e.g., intensity, frequency) of sounds at which TTS and PTS occur. Permanent threshold shifts are less species-dependent and more dependent on the length of time the peak pressure lasts and the signal rise time. If exposure time is short, hearing sensitivity is usually recoverable. Hearing loss might be permanent if exposure to a sound is constant

over a long period or if the sound is broadband in higher frequencies and has intense sudden onset. Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, resonance effects, and other types of organ or tissue damage.

Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson, 1995a; Ketten, 1998). To date, there is no conclusive evidence that seismic survey sounds cause auditory impairment or other physical effects on marine mammals.

5.2.1.2 Behavioral Effects

Behavioral response may take the form of startle, avoidance, attraction, flight, alteration of calling rate and frequency, alteration of orientation, alteration of pre-exposure activity, alteration of diving and breathing frequency, alteration of swim speed and no reaction. Available evidence also indicates that behavioral reaction to sound, even within a species, may depend on the listener's sex and reproductive status, possibly age and/or accumulated hearing damage, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary depending on the type, duration and frequency of exposure of sound.

Response may be influenced by whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability, in a given situation, to predict the behavioral response of a species, or on classes of individuals within a species, to a given sound.

When noise interferes with sounds used by marine mammals (e.g., interferes with their communication), it is said to "mask" the sound (a call to another walrus might be masked by an icebreaker operating a certain distance away). Noises can cause the masking of sounds that marine mammals need to hear to function (Erbe et al., 1999). If sounds used by the marine mammal are masked to the point where they cannot provide the individual with needed information, they can cause harm (Erbe and Farmer, 1998).

5.2.2 Background on Effects of Vessel Traffic

Vessel operations occur throughout the Beaufort Sea and Chukchi Sea Planning Areas to conduct pre-lease surveys and on or in the vicinity of existing leases during seasonal seismic surveys as noted above. These vessels operate primarily during open-water and early winter periods. Vessels and their operations produce effects through a visual presence; traffic frequency and speed; and operating noise of on-board equipment, engines, and in the case of icebreakers engine and ice breakage noise. Listed species may be exposed to vessels when seasonal distribution and habitat selection overlaps in time and space with proposed exploration vessel activities. Noise from seismic sources will be considered separately.

For offshore oil and gas exploration operations vessels provide the primary platform for the various open water season and in-ice (late fall/early winter during seasonal ice formation) seismic surveys and secondary support for these surveys such as monitoring, crew transfer; fuel, equipment and supplies delivery; and ice-management. Vessels also provide similar support functions for the transport, placement, construction and operation of exploration drilling platform facilities. In-ice seismic surveys and some late fall/early winter drilling facilities also require icebreaker operations.

5.2.2.1 Large Vessels

Large vessels employed for oil and gas exploration activities range from 75 m to 110+ m in length. Speeds range from 4.5 knots when towing seismic gear up to 16.5 knots when transiting. Operations historically were confined to the open water period; however, recently technology to conduct in-ice seismic surveys during the late-fall/early winter period, when new ice is forming, but not exceeding 1.6 m in thickness is now feasible. Vessel activity occurs 24 hours a day including periods of poor

visibility due to darkness and weather conditions. Vessels that perform as floating drilling platforms may be considered large vessels as well.

Laist et al. (2001) noted 89% of all collision accounts pertained to whales that were killed or severely injured from vessels moving at 14 knots or faster. None of these collisions occurred at speeds of less than 10 knots. Also, collision records first appear late in the 1800s when the fastest vessels began attaining speeds of 14 knots, and then increased sharply in the 1950s-1970s when the average speed of most merchant ships began to exceed about 15 knots. Large vessels in the Arctic Region typically operate at less than 10 knots when conducting seismic operations or when positioning at a drill site. These large vessels, when towing seismic gear or positioning a drill rig, cannot perform abrupt turns and cannot slow speeds over short distances to react to encounters with marine mammals.

5.2.2.2 Medium and Small Vessels

Medium and small vessels are used to support refueling operations and equipment/personnel transport. These vessels are <75 m long and have the ability to slow down in relatively short distances and make rapid turns to avoid collisions with marine mammals. These vessels may operate at speeds greater than 10 knots during supply missions and operate in periods of darkness and poor visibility. Collisions with listed species could occur under such conditions, but have not been reported in the Arctic OCS.

5.2.2.3 Ice Breakers

Some exploration activities require icebreaker support. Icebreaker support for ice breaking or ice management for in-ice seismic surveys and drilling operations can introduce loud noise episodes into the marine environment. When actively engaged in ice management or ice breaking, cavitation of the propellers occurs when higher power levels are required to move ice or ram/run up on ice for breakage. Davis and Malme (1997) noted “cavitation is a frequent occurrence during ice breaking if a ship has to reverse and repeatedly ram thick ice. Cavitation noise is created when the propeller is switched from astern to forward or when the ship has stalled in the ice after ramming, producing much higher noise levels than continuous forward progress through the ice.” This noise is much greater than when in transit. Icebreaker noise may occur near habitats used by individual or small groups of listed species.

In order to address the potential for icebreaking to adversely affect the ice habitat itself or alter the mechanical behavior of the surrounding ice, BOEMRE supported a literature review and analysis by subject matter experts with an emphasis on Arctic expertise (Mahoney, 2010). This review and analysis suggested that icebreaker activity in fall/winter, when temperatures are cold and the ice is forming quickly, has very little impact on the availability of ice as habitat. Icebreaker track lines refreeze very quickly, within a matter of several hours in many cases. Icebreaker effects are overshadowed by the natural variation in land fast ice, which involves constant re-breaking, and even more so in pack ice. In spring when the ice is melting and retreating further north the effects would be more prolonged and widespread. Any icebreaking activity in spring/summer could open new leads which could remain open and expand as the open water absorbed more light and further melting occurred.

5.2.3 Background on Effects of Aircraft Traffic

Aircraft can affect listed species due to presence and airborne noise. Two types of aircraft are evaluated; fixed-wing and helicopter.

5.2.3.1 Fixed Wing

Exploration geophysical surveys and drilling operations may be supported by fixed wing aircraft. Fixed wing operations typically assess marine mammal habitat use, distribution, movement, behavior before, during, and after seismic surveys and drilling operations occur. Monitoring surveys are

typically conducted with aircraft flying above 1,500 ft AGL unless safety due to weather or other factors becomes an issue. Greene and Moore (1995:102-105) explained fixed wing aircraft typically used in offshore activities were capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 162 dB re 1 μ Pa-m at the source. Aircraft on a direct course usually produce audible noise for only tens of seconds, and the marine mammals are likely to resume their normal activities within minutes (Richardson and Malme, 1993). Reaction frequency typically diminishes with increasing lateral distance and with increasing altitude. Individual responses appear to vary depending on flight altitude and received sound levels.

5.2.3.2 Helicopters

Exploration geophysical surveys and drilling operations may be supported by helicopters engaged in crew and equipment transport. Most helicopter use on the Alaska Region OCS is for ferrying personnel and equipment to offshore operations and involves turbine helicopters. Surveys and drilling operations may involve variable numbers of trips daily or weekly depending on the specific operation. The more independent surveys and drilling operations being conducted simultaneously the more aircraft effort and distribution of overflights occurs. Helicopter operations are conducted 1,000 to 1,500 feet AGL/ASL unless safety due to weather or other factors becomes an issue. Greene and Moore (1995:102-110) explained helicopters commonly used in offshore activities radiate more sound forward than backwards, and are capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 151 dB re 1 μ Pa-m at the source. By radiating more noise forward of the helicopter, noise levels will be audible at greater distances ahead of the aircraft than to the aircrafts rear.

The helicopter sounds measured underwater at depths of 3 and 18 m showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m from a Bell 212 flying overhead at 150 m ranged from 117-120 dB re 1 μ Pa in the 10-500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 150 m ranged from 112-116 dB re 1 μ Pa in the 10-500-Hz band. Helicopter noise is generally audible for only tens of seconds.

Individual responses appear to vary depending on flight altitude and received sound levels. Several reports document the responses of pinnipeds to low-flying aircraft. The effect is more pronounced in areas where air traffic is uncommon and with helicopters vs. fixed wing aircraft. Richardson (1995b) noted pinnipeds hauled out for pupping or molting are the most responsive to aircraft.

5.2.4 Background on Effects of Seismic Surveys

Marine mammal responses to oil and gas related sound have varied. Airguns can be of different sizes and can be combined into different array configurations. All seismic survey operations using airguns may be conducted 24 hours a day depending on weather, sea state, ice and operational considerations. To improve operational efficiency, seismic surveys stay active as many days as possible. Because of delays due to weather, equipment, and other reasons, not all seismic surveys are operated continuously, but rather will have periods when the airguns are silent.

The various types of seismic surveys using airguns include open water surveys, in-ice seismic surveys using an icebreaker, and on-ice seismic surveys using rollogons on land fast ice. Seismic surveys may be 2D or 3D. The 2D and 3D surveys use similar survey methods but different operational configurations. Three-dimensional (3D) survey lines are spaced closer together and are concentrated in a specific area of interest. These surveys provide the resolution needed for detailed geological evaluation. A 2D survey provides less-detailed geological information because the survey lines are spaced farther apart. These surveys are used to cover wider areas and map geologic structures on a regional scale. However, one is not necessarily louder than the other. BOEMRE requires that companies use the lowest possible airgun size to acquire the desired data. Ancillary activities may

include the use of one or more airguns for shallow hazard clearance, typically at very low sound levels and over a small area as compared to deep-penetration 2D/3D surveys. The level of sound associated with the survey will be dependent upon the size of the airgun array. In addition to industry surveys, the military and research vessels also use seismic arrays. For example, military vessels conducted an area-wide survey in the Gulf of Alaska recently, and NSF sponsored an icebreaker (in-ice) oceanographic survey in the Arctic Ocean that included a seismic survey component.

In-ice surveys use an icebreaker to break newly formed ice ahead of the seismic source vessel. The source vessel tows an underwater airgun array. Depending on the timing and location of an in-ice survey, some marine mammals could experience noise from both the ice breaking and airgun sound sources if they are in the vicinity of newly forming ice. Potential impacts include disturbance and displacement.

On-ice surveys are limited to shore-fast ice in the Beaufort Sea. On-ice surveys are not anticipated for the Chukchi Sea. During on-ice seismic, or vibroseis surveys, rollogons are used to transport crews and equipment to nearshore locations in order to conduct seismic surveys. Camps are set up on the ice to accommodate the crews. With the vibroseis technique, activity on the surveyed seismic line begins with the placement of geophones (receivers). All geophones are connected to the recording vehicle by multi-pair cable sections. The vibrators move to the beginning of the line and recording begins. The vibrators then move along a source line, which is at some distance or angle to a receiver line. The vibrators begin vibrating in synchrony via a simultaneous radio signal to all vehicles.

5.2.5 Background on Effects from Drilling Operations

Exploration drilling operations are described in greater detail in the scenarios in Section 2.2.3.1. Drilling units can be sources of noise and disturbance to listed species. Potential adverse effects include displacing listed species from the vicinity of drill sites. Drill sites could be located in feeding areas or migration paths. Drilling can be conducted from fixed or bottom-founded platforms or drillships. Drilling operations generate underwater sounds that are quite different than seismic surveys because the sounds are of a continuous nature and tend to be from a stationary source whereas seismic surveys are impulsive sounds from a constantly moving location.

Exploration drilling may be conducted using several types of fixed offshore drilling platforms in the Alaska Beaufort and Chukchi seas. The type of rig chosen is based on the characteristics of the well site's physical environment, water depth, expected drilling depth, and the mobility required based on weather and ice conditions. These mobile drill rigs travel at less than 10 kn; they are towed or self-propelled from one site to another.

The most likely rig types to be used include dynamically positioned (DP) drill ships and jack-up platforms. The existing shallow shelf leases in the Chukchi and Beaufort OCS are suitable for these types of platforms and are appropriate for water depths up to 500 feet.

The results of numerous acoustical studies at the Northstar production facility indicated that underwater sound produced from construction and oil-production activities attenuate rapidly and reach background levels within a few kilometers of the sound source (Blackwell and Greene 2001, 2006). The distance over which construction sounds would remain above ambient sound levels would depend upon the depth of the water, sea state and other factors. Pile driving is potentially one of the loudest sounds associated with construction. Parvin and Nedwell (2006) found that the sound produced by pile driving dropped below ambient noise levels at between 5 and 10 km.

5.2.5.1 Drilling Sounds

Exploration drilling in the OCS would likely be conducted from a drillship or a jack up rig. The level of sound propagation would depend upon a combination of factors including the precise drillship used, the water depth and location. Draft plans have indicated that industry may use the *Kulluk* or the *Discoverer* or something similar. Both the *Kulluk* and the *Discoverer* are vessels specifically prepared

for operations in the Arctic. Underwater sound propagation results from the use of generators, drilling machinery, and the rig itself. Sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during exploration drilling operations (Greene 1987b), and underwater sound appeared to be lower at the bow and stern aspects than at the beam (Greene 1987a). The following information is excerpted from draft exploration plans on file with BOEMRE.

Most drilling sounds generated from vessel-based operations occur at relatively low frequencies below 600 Hertz (Hz) although tones up to 1,850 Hz were recorded by Greene (1987a) during exploration drilling operations in the Beaufort Sea. At a range of 0.11 mi (0.17 km) the 20-1,000 Hz band level was 122-125 dB for the drillship Explorer I. Underwater sound levels were slightly higher (134 dB) during drilling activity from the Explorer II at a range of 0.12 mi (0.20 km) although tones were only recorded below 600 Hz. Underwater sound measurements from the *Kulluk* at 0.61 mi (0.98 km) were higher (143 dB) than from the other two vessels.

5.2.5.2 Vertical Seismic Profile Sounds

A typical eight airgun array ($4 \times 40 \text{ in}^3$ (655 cm^3) airguns and $4 \times 150 \text{ in}^3$ (2,458 cm^3) airguns) would be used to perform ZVSP surveys, if conducted after the completion of each exploratory well. A typical survey will last 10–14 hours, depending on the depth of the well and the number of anchoring points, and include firings of the full array, plus additional firing of a single 40-in^3 (655 cm^3) airgun to be used as a “mitigation airgun” while the geophones are relocated within the wellbore. The estimated source level used to model sound propagation from the airgun array is $\sim 241 \text{ dB re } 1 \mu\text{Pa} \cdot \text{m rms}$, with most energy between 20 and 140 Hz. Airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. A typical high-energy airgun arrays emit most energy at 10–120 Hz. However, the pulses contain significant energy up to 500–1,000 Hz and some energy at higher frequencies (Goold and Fish, 1998; Potter, Thillet, Douglas et al., 2007).

Southall, Bowles, Ellison et al. (2007 Appendix C) reviewed a number of papers describing the responses of marine mammals to non-pulsed sound. In general, little or no response was observed in animals exposed at received levels from 90-120 dB. Probability of avoidance and other behavioral effects increased when received levels were 120-160 dB.

5.2.6 Background on Effects from Discharges

5.2.6.1 Authorized Discharges

The principal regulatory method for controlling pollutant discharges from vessels (grey water, black water, coolant, bilge water, ballast, deck wash, etc.) into waters of the Arctic Region OCS is the Clean Water Act (CWA) of 1972. Section 402 establishes the National Pollution Discharge Elimination System (NPDES). The EPA issued an NPDES Vessel General Permit (VGP) for “Discharges Incidental to the Normal Operation of a Vessel” for Alaska was finalized in February, 2009. The final VGP applies to owners and operators of non-recreational vessels that are 24 m (79 ft) and greater in length, as well as to owners and operators of commercial vessels of less than 79 ft which discharge ballast water.

The general NPDES permit AKG-28-0000 (EPA, 2006) authorizes discharges from oil and gas exploration facilities. The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. The current NPDES General Permit for wastewater

discharges from Arctic oil and gas exploration expired on June 26, 2011. Prior to the 2012 drilling season, EPA will reissue separate NPDES General Permits for exploration in the Beaufort Sea and in the Chukchi Sea, respectively. EPA expects that tribal consultation and public comment on the new proposed Arctic oil and gas exploration permits would occur in fall 2011.

5.2.6.2 Background on Effects from Oil spills

Physical/physiological effects of particular concern include:

- Fouling of fur or feathers may cause hypothermia, inhibit movement or flight, and lead to ingestion of oil during grooming attempts.
- Irritation, inflammation, or necrosis of skin chemical burns of skin, eyes, mucous membranes inhalation of toxic fumes with potential short- and long-term respiratory effects (e.g., inflammation, pulmonary emphysema, infection).
- Ingestion of oil (and dispersants) directly or via contaminated prey, leading to inflammation, ulcers, bleeding, possible damage to liver, kidney, and brain tissues.
- Stress from presence of vessels, aircraft, and noise.
- Complications of the above may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death.

Spills are unauthorized events. All operations require spill prevention and oil spill response plans, which outline equipment, personnel, and infrastructure associated with the required plans. Depending on the location, timing, duration, sea state, climatic conditions, and response to a spill, listed species could be affected. A large spill event occurring during the late summer could overwinter and result in contact with polynyas the following spring; however, weathering would decrease the volatility and toxicity of the spilled oil.

Listed species could be contacted by oil (direct contact, ingestion), inhale vapors, or forage on contaminated or diminished prey resources. Listed species can also be affected by spill response and clean-up activities.

5.2.6.3 Background on Effects from Response and Cleanup Activities

Listed species could also be affected by spill response and cleanup activities. Cleanup activities following an oil spill could involve multiple marine vessels operating in the spill area for extended periods of time. After a large spill, there typically are helicopter and fixed-wing aircraft overflights to track the spill and to monitor distributions of marine wildlife. Monitoring the location of specific marine animals helps guide response in an effort to prevent oil from contacting important animal concentrations or concentration areas.

5.3 Effects Analysis for Marine Mammals

Exploration activities can result in direct and indirect effects. Cumulative effects result from direct and indirect effects combined with the environmental baseline (Chapter 4) and reasonably certain future activities (Section 5.4). Direct and indirect effects to marine mammals occur from vessel and aircraft traffic, seismic surveys, drilling operations, and discharges associated with the Proposed Action.

We have divided our discussion of effects into two sections: (1) Exploration, and (2) Development and Production. These reflect the incremental analysis of the consequences of the phases of oil and gas activities with emphasis for this document on the exploration phase and addressing the more speculative later phase of development and production in more general terms to allow the FWS, in generating a Biological Opinion, to assess the potential for the Proposed Action to jeopardize listed species.

At this time industry holds leases on 487 lease blocks from previous lease sales in the Chukchi Sea and 183 lease blocks from previous lease sales in the Beaufort Sea (Table A and Figure A). Of these, three blocks are producing oil (BP Alaska Inc.'s Northstar project) and two blocks are in development (BP Alaska Inc.'s Liberty project).

Air emissions associated with typical exploration activities were evaluated by the Environmental Protection Agency in 2011 under the Clean Air Act. Emissions from exploration vessels, including drillships were determined not to have an adverse effect on listed species or critical habitat. The full EPA analysis is included in Appendix B. This potential source of impact is not considered further in this Biological Evaluation.

5.3.1 Direct and Indirect Effects of Exploration on Marine Mammals

5.3.1.1 Polar bears and Polar Bear Critical Habitat

This section refers to the Chukchi/Bering seas (CBS) stock of polar bears and the Southern Beaufort Sea (SBS) stocks of polar bears, and potential effects of the Proposed Action on polar bear the critical habitat established for polar bears within the U.S. and U.S. waters. There is a substantial area of overlap between the two stocks, and activities in the western Beaufort Sea and the northern Chukchi Sea would have the potential to impact both populations. Individual polar bears from the northern Beaufort Sea stock may also travel into the northeastern U.S. Beaufort Sea in some years.

Exploration Associated Activities

The principal sources of potential adverse effects to polar bears or to polar bear critical habitat in the Beaufort Sea and Chukchi Sea OCS from BOEMRE exploration activities include the following:

- Vessel traffic
- Terrestrial and on-ice vehicle traffic
- Aircraft traffic
- Seismic Surveys
- Exploration drilling operations
- Authorized discharges
- Petroleum spills

5.3.1.1.1 Vessel traffic

Most vessel traffic in the in the Alaskan Arctic occurs near shore and is associated with local subsistence fishing and hunting, travel between villages, and supply ships and barges serving local villages or the oil industry. Increasingly, cruise ships, icebreakers, U. S. Coast Guard operations, and scientific research vessels (including icebreakers) operate in the Chukchi and Beaufort seas. Open water traffic at present is limited primarily to summer and early autumn. Icebreakers may be active at any time of year; annual scientific research cruises typically take place in spring. BOEMRE associated vessel traffic typically enters the Arctic after July 15 and departs before the end of December. Encounters between vessels and polar bears are less likely to occur in open water.

Vessels associated with OCS lease exploration include open water seismic operations in summer and early fall, and scientific research operations associated with lease areas. Seismic operations typically include a single source vessel; several support vessels, and occasionally an icebreaker. Crew change outs typically occur by small boat or helicopter. Vessels are required to have marine mammal observers on board and to shut down operations if marine mammals enter within the 180/190 dB range (180 for walrus and all cetaceans, 190 for polar bears and ice seals.) Vessels are also used during ancillary operations such as ice gouge and shallow hazard surveys which are used to identify possible pipeline routes and drilling sites, etc. While most industry associated vessel traffic occurs on or near the lease areas, ancillary activities may be near shore as well.

Vessel traffic which occurs in the open water is unlikely to affect polar bears simply because few polar bears will be present. Some vessels have occasionally reported seeing a swimming polar bear in open water. Vessel presence and noise may temporarily disturb small numbers of polar bears resting or foraging on marine mammal carcasses along the coast or on barrier islands. Potential impacts to polar bears from open water activities are expected to be limited to the short term disturbance of small numbers of individuals. Most vessels operating in the open water are not expected to have any impacts on critical habitat. Some vessels conducting ancillary activities or traveling nearshore may cross the 1 mile buffer zone around Unit 3, barrier island habitat. For example, the Mary Sachs entrance in the Beaufort Sea is a common route for vessels. The level of occasional boat traffic that is anticipated in association with OCS activities would be very low, 1-3 round trips per week if exploratory drilling were taking place in the Beaufort Sea. This would not affect the primary constituent elements (PCEs) of Unit 3. In other words, occasional boat traffic would not affect the availability of barrier islands for resting, movements ashore or to foraging areas. Vessel traffic in the open water would not affect terrestrial denning habitat (Unit 2) or sea-ice habitat (Unit 1).

Icebreaking

Icebreakers may accompany some OCS authorized activities such as drill ships or in-ice seismic operations. In most cases, the icebreakers would primarily be used for ice management (e. g., pushing away large floes) or opening a path in first year ice. Polar bears may be drawn to or displaced by icebreaker traffic (Brueggeman et al., 1991), resulting in temporary disturbances while foraging or resting. Polar bears may expend energy to avoid ships in the lead systems, or conversely, may take advantage of leads opened by ice breakers. Ringed seals have been observed to take advantage of temporary leads opened by icebreakers, and polar bears could be drawn to the availability of ringed seals while foraging. Icebreakers may be stationed with drilling rigs (up to 2 per sea per year) or associated with in-ice seismic operations. To date, one operator has proposed in-ice surveys, but none have taken place. Given the few icebreakers that would operate in conjunction with OCS activities, such disturbances are anticipated to be infrequent and short term, and to have minimal energetic costs to a few individual polar bears.

In addition, icebreaker activity may alter habitat used by polar bears. To address the potential for icebreaking to adversely affect the ice habitat itself or alter the mechanical behavior of the surrounding ice, BOEMRE supported a literature review and analysis by subject matter experts with an emphasis on Arctic expertise. This review and analysis suggested that icebreaker activity in fall/winter, when temperatures are cold and the ice is forming quickly, have very little impact on the availability of ice as habitat. Icebreaker track lines refreeze very quickly, within a matter of several hours in calm weather. Icebreaker effects are overshadowed by the natural variation in land fast ice, which involves constant re-breaking. Icebreaker effects are even less evident in pack ice, which is constantly moving, fracturing and re-forming (Mahoney, 2010).

In spring when the ice is melting and retreating further north the effects would be more prolonged and widespread. Any icebreaking activity in spring/summer could open new leads which could remain open and expand as the open water absorbed more light and further melting occurred. Impacts from icebreaker tracklines in fall/ winter would be very short term (Mahoney, 2010). OCS activities involving icebreakers in the Beaufort or Chukchi seas would take place in summer through fall (approximately July –December). During this time period, sea ice would readily refreeze. . Ice breaking of multi-year ice is not anticipated in association with OCS activities.

Icebreaking activity associated with OCS activities would include ice management around a stationary drill ship or rig. In this case, the ice breaker would be stationed “up wind” of the rig and would be used to push large ice floes away from the rig, or to break up smaller sheets of ice before they piled up onto the rig and became a safety hazard. The icebreaker may be 1-5 km from the rig, depending upon the rate of flow of the ice. An area of a few square km would be kept clear of ice while the rig remained on site. Ice typically closes in behind the rig within a similar distance since the

flow of the ice determines both how far ahead of the rig the icebreaker must be and how quickly the ice moves back in after it is past the rig. Icebreakers may also be used to accompany a seismic ship or other vessels while traversing through the Arctic. In most cases this would primarily be a safety precaution, and vessels that are in transit would avoid ice as much as possible for safety and fuel efficiency reasons. Icebreakers that were conducting in-ice seismic operations would operate primarily in open water and newly forming first year ice (gray ice). In this case, the track lines could cover 100's or 1000's of kilometers, but the ice would typically refreeze behind the vessels within a few hours. They would not be able to conduct in-ice seismic surveys in ice that was thicker than ~1.5m due to limitations of the equipment. Icebreaking traffic would not typically occur in close proximity to terrestrial denning habitat or barrier islands (Units 2 and 3 of polar bear critical habitat) and would not be likely to adversely impact the availability of these habitats for polar bears. Unit 1 of critical habitat, sea ice, provides a platform for polar bears for breeding, foraging, movements and denning. The Service has designated 499,552 km² (192,928 mi²) of sea-ice habitat as polar bear critical habitat in U.S. waters. Additional sea-ice habitat used by SBS and CBS polar bears exists in the Canadian Beaufort Sea and in the Russian Chukchi Sea. Given the transitory nature of the effects on ice from ice breaking, and the wide extent of sea ice available relative to the small footprint of OCS activities in any given year, OCS activities would not appreciably diminish the availability of sea ice for polar bears for breeding, foraging or denning are anticipated, therefore no adverse modification of critical habitat is anticipated.

5.3.1.1.2 Terrestrial Vehicle Traffic

Sources of motorized travel on the North Slope include local transit from village to village, subsistence activities, industry activities, scientific research, and some guiding and tourism. Polar bears may be displaced or disturbed by ground transportation, such as snow machines, heavy industrial vehicles, or rolligons. On average, polar bears react to avoid snowmobiles at a distance of approximately 1 km and may be displaced by as much as 3 km. Females with cubs react at greater distances and with more intense and persistent responses, thus expending more energy, than adult males or lone adult females. Polar bears may take flight to avoid snow machines before having been detected by the rider (Andersen and Aars, 2008). Although it is very difficult to assess population-level effects from repeated short-term disturbance of individual animals, bears that already are nutritionally stressed may be impacted by repeated disturbances over time (Evans, 2008, pers. comm.). In addition, polar bears are vulnerable to heat stress (Best, 1982; Stirling, 1988), and they may become overheated if forced to run to evade vehicles in warm weather. Impacts, if any, are likely to occur near shore, as very little motorized vehicle takes place more than 20 km offshore. The SBS polar bears may form aggregations of 20-60 bears at Cross Island and/or near Kaktovik and Barrow in the late summer/early fall while waiting for sea ice to form. Large aggregations of polar bears do not seem to occur as regularly along the US side of the Chukchi Sea as they do along the Russian coastline of the Chukchi Sea or the Beaufort Sea coastline, however, this may change as changing sea-ice conditions continue to affect polar bear distribution. As bears spend more time onshore, they may be at increased risk of overheating or stress reactions due to disturbance events. The SBS population of polar bears commonly den along the northeastern coast of the Beaufort Sea in Alaska. The CBS population of polar bears den on Wrangell and Herald islands, along the Russian coast of the Chukchi Sea, and to a lesser extent along the U. S. coast of the Chukchi Sea. Denning polar bears are more sensitive to disturbance in the fall, but the energetic costs of disturbance may be higher in the spring. Polar bear cubs forced to leave dens early due to motorized vehicle disturbances are at increased risk of predation and mortality from other causes. There is some evidence that some bears may habituate to noise. Smith, Partridge, Amstrup et al. (2007) found that polar bears using dens between 1 and 2 km from ice roads were less vigilant than polar bears not exposed to industry activities, indicating that the bears may have become acclimatized to the activity and no longer perceived it as a risk (Smith, Partridge, Amstrup et al., 2007; Amstrup, 1993). In other instances, polar bears have abandoned dens due to human activities in the vicinity (Perham, 2008, pers. comm.). Identifying denning habitat and monitoring changes in habitat use is critical when evaluating the

effects of activities on the polar bear population. Protecting core maternity denning areas from disturbance is of critical importance to the long-term conservation of polar bears.

Few shore-based activities take place in conjunction with OCS exploration activities. Crew change outs typically occur in Deadhorse, Barrow, Wainwright or another village near the proposed activity. Some staging of equipment for oil spill response contingency plans, or for re-supply may be stored at a village or at a site in Prudhoe Bay. OCS exploration activities are not likely to result in the use of terrestrial routes outside of villages or airports, or previously established sites within Prudhoe Bay. Some equipment may be moved to the North Slope via the haul road. Impacts to polar bears or polar bear critical habitat from terrestrial vehicle traffic associated with OCS activities are not anticipated.

5.3.1.1.3 Aircraft Traffic

Polar bears may be disturbed while resting or during foraging activities by low flying aircraft. Sight seeing flights, private pilots, industry related flights and regular commercial coastal flights all may come into contact with polar bears. Polar bears may be displaced temporarily by aircraft or may expend energy reserves avoiding aircraft. Requirements that industry flights stay at 1500 ft or above ground level and avoid overflights of important polar bear areas such as Cross Island help to reduce the potential for disturbance. Establishing flight corridors several miles inland for industry flights has also reduced the potential for impacts to polar bears from industry flights since most polar bears use the coastline and barrier islands to move between areas. Flight corridors established from shore bases to offshore industry operation sites reduce the potential for disturbances by limiting the spatial extent of the over-flights. Flight routes are often designated through the LOA process, but typically are several kilometers inland or offshore. Some OCS operations involve a large number of fixed wing and helicopter flights, for example, there are 100-200 helicopter flights per open water season between Northstar and West Dock. Additional flights associated with OCS activities take place in conjunction with open water seismic operations and exploration drilling; these are primarily for crew changes, re-supply flights and marine mammal surveys in the Beaufort Sea, required by the terms of LOAs/ IHAs. Flights are limited to the summer season due to weather constraints. Additionally, industry operations are usually limited to VFR flight and cannot operate in darkness, nor can they operate in temperatures below -30 – 40 f. (-34—40C) for safety reasons. Fixed wing and helicopter flights likely result in short term disturbances of some polar bears. To date, OCS associated aircraft flights have had a negligible impact to some individual polar bears (76 FR 13454, 73 FR 33212). Fixed wing and helicopter flights associated with OCS activities do not result in an adverse modification to any of the three units of polar bear critical habitat because of their short duration, limited seasonal use, and flight level and route restrictions.

5.3.1.1.4 Seismic Surveys

Open Water Seismic Operations

Polar bears are closely tied to the presence of the sea-ice platform for the majority of their life functions, including hunting (Amstrup, 2003). It is unlikely that open-water seismic activities will impact polar bears or the abundance and availability of ringed and bearded seals, which are the primary prey of polar bears. Seismic operations typically are not concentrated in any one area for extended periods; therefore any impacts to polar bears would be limited to short term disturbances. Polar bears normally keep their heads above or at the water's surface when swimming, where underwater noise is weak or undetectable (Richardson, 1995b). Direct impacts potentially causing injury from open-water seismic surveys are possible if animals entered the 190-dB zone immediately surrounding the sound source. There also is the possibility that bears could be struck by seismic vessels or exposed to small-scale fuel spills, although these risks are considered unlikely to occur. Vessel traffic associated with seismic-survey activity is not expected to cause impacts to polar bears, because polar bears show little reaction to vessels and generally do not linger in open water. Brueggeman et al. (1991) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and

watching, walking/swimming away) to the vessel, their responses were brief. Seismic surveys have the potential to disturb polar bears that are swimming between ice floes or between the pack ice and shore. Swimming can be energetically expensive for polar bears, particularly for bears that engage in long-distance travel between the leading ice edge and land. Bears that encounter seismic operations may be temporarily deflected from their chosen path, and some may choose to return to where they came from. However, bears swimming to shore are most likely heading for reliable food sources (i.e., areas where ringed seal concentrations are high or Native-harvested marine mammal carcasses on shore), for which they have a strong incentive to continue their chosen course. Therefore, although some bears may be temporarily deflected and/or inhibited from continuing toward land due to seismic operations, this interruption likely would be brief in duration. Due to the vast area over which seismic surveys will be conducted, and that seismic operations will be curtailed during the bowhead migration (due to aggregations of migrating whales), which coincides with the time that large numbers of bears swim for land, the number of bears affected in this manner likely would be very small. Steps taken to avoid conflicts between seismic operations and bowhead whale-subsistence hunts also benefit polar bears. Because the whale hunts coincide with the time that many bears come ashore, particularly in the Kaktovik area, the impact to swimming polar bears would be mitigated to some extent. Ultimately, few bears are likely to be substantially affected by seismic operations during the open-water period. For most of the year, polar bears are not very sensitive to noise or other human disturbances (Amstrup, 1993).

On-Ice Seismic Operations

On-ice seismic operations typically occur between January and May in the Beaufort Sea. These are near shore operations that take place on shorefast ice. A support base camp is typically located nearby, either on grounded ice or onshore and may house as many as 120 people for a big operation. Tracked vehicles are used to access the survey areas from that location. The surveys typically use only vibrator sources. Helicopters are typically used for transport during the ice verification process. Surveys may be conducted over 100's or 1000's of linear miles, with a predefined number of vibration points per mile, and shots (or sweeps) at each vibration point. The standard distance between vibration points is 67m. Vibraseis tracked vehicles may be 68,000 lb tracked vehicles, or 20,000 lb. mini-vibraseis tracked vehicles.

Polar bears den in coastal areas of the Beaufort Sea, and move through this area while hunting for the ringed seal, their principal prey. Mortality rates increase when polar bear cubs are forced to leave their dens prematurely, prior to reaching their optimum size and weight. Disturbance from oil industry activities has been documented to cause polar bears females with cubs to abandon their den sites early. Pregnant females and those with newborn cubs in maternity dens are sensitive to noise and vehicular traffic (Amstrup and Gardner, 1994). On-ice seismic surveys have the potential to disturb female polar bears in dens along the coast or on shorefast ice. On-ice seismic operations that take place nearshore, or land-based seismic operations that take place nearshore, could impact polar bears through displacement of bears or their prey. Polar bears could be displaced from preferred denning habitat in some instances. Polar bears also could be displaced from shorefast ice, which is where ringed seals tend to have their lairs and, therefore, be forced to forage in less productive areas. Displacement of polar bears or ringed seals would be relatively short term, lasting only for the duration of the surveys. Like open water seismic surveys, equipment and personnel move from one area to another as quickly as possible, so that the footprint of activity at any given moment in time is limited to the length of seismic lines and surrounding equipment (perhaps 10-20 km). Displacement of denning polar bears could have more serious consequences. Cubs forced to leave dens prematurely due to disturbance are at increased risk of hypothermia and may be unable to keep up with the adult female or to avoid predation by adult males.

Discussions with FWS Marine Mammals Management personnel indicate that FWS believes that polar bears are adequately protected from harmful effects as long as operators abide by the terms of the Letter of Authorization issued by FWS. Mitigation measures typically used for these types of

surveys may include overflights using dogs to locate active dens as well as seal lairs, which are then avoided. Typically, polar bear dens are subject to a one mile no disturbance zone, though the distance may be more or less depending upon the specific situation.

The degree of incidental take associated with on-ice seismic surveys has typically been limited to the temporary displacement of some non-denning bears from the area. This short term displacement is insignificant to the polar bear population, and unlikely to adversely affect polar bears in the project area in the Proposed Action area.

In-Ice Seismic Operations

In ice seismic operations use an icebreaker in conjunction with a seismic vessel to extend the seismic survey season later into the fall when new ice is beginning to form. Polar bears may be impacted by noise and disturbance from seismic and icebreaker activities or from changes to their sea-ice habitat from icebreaking. Polar bears that are encountered while on the ice are unlikely to be physically impacted by air gun effects. Polar bears in the water are usually swimming near the surface. Received sound levels near the surface are substantially reduced due to the pressure release effects near the water surface (Amstrup, 2003; Amstrup and DeMaster, 1988). The most likely impacts to polar bears from seismic surveys and associated activities would be disturbance and possible impacts to bears' food resources. Reactions to vessel noise, icebreaking or seismic sound would be similar. Polar bears on ice may move into the water to avoid the area that the vessels are operating in. Polar bears may be stressed by energy expenditures related to avoiding ships or traffic in the lead systems. Polar bears may move away from the icebreaker and seismic ship at distances of several kilometers. Anderson and Aars (2008) found that on average, polar bears react to avoid snowmobiles at a distance of approximately 1 km and may be displaced by as much as 3 km. Females with cubs react at greater distances and with more intense and persistent responses, thus expending more energy, than adult males or lone adult females. Brueggeman et al. (1991) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and watching, walking/swimming away) to the vessel, their responses were brief. Although it is very difficult to assess cumulative population-level effects from short-term disturbance of individual animals, bears that already are nutritionally stressed may be impacted by repeated disturbances over time. In addition, polar bears are vulnerable to heat stress (Best, 1982; Stirling, 1988), and they may become overheated if forced to run to evade vessels in warm weather.

Any impacts of seismic activity to polar bear food resources will probably be minor, local and brief in nature. Bearded and ringed seals are the primary prey of polar bears in the action area, and abundance and availability of these seals are not expected to be significantly altered by the proposed seismic surveys and associated activities. Polar bears may be drawn to icebreaker and seismic vessels by curiosity or may avoid them. Reactions vary by individual bear, with females with cubs being the most cautious. If ringed seals are drawn to the open leads created by the icebreaker, polar bears may be drawn to the area as well. The location of leads influences the distribution of foraging polar bears (Stirling, 1997), and they may take advantage of leads created by icebreakers, however leads created by icebreakers tend to refreeze quickly. Polar bears have been observed to take advantage of the leads that form downstream of drilling platforms, which are routinely used by seals (Stirling, 1988).

Winter ice-breaking activity has some potential to affect polar bears denning in sea-ice habitats <300 m water depth. The distribution of maternal dens appears to have changed in recent years; from 62% offshore dens (1985-1994) to 37% offshore dens (1998-2004) (Fischbach, 2007; Fischbach, Amstrup, and Douglas, 2007). Fischbach, Amstrup, and Douglas (2007) concluded that the changes in the den distribution were in response to delays in ice formation and reduced availability and quality of the more stable pack ice suitable for denning, due to increasingly thinner and less stable ice in the fall. Amstrup and Gardner (1994) noted that only a small proportion (4%) of the southern Beaufort Sea polar bear population den on the shore-fast ice adjacent to the mainland coast of Alaska. The overall occurrence of dens on sea ice in the Arctic is thought to be relatively low based on current studies

using radio-telemetry (Amstrup, 1995; Amstrup, Stirling, Smith et al., 2006) and is decreasing as more polar bears den on land (Schleibe, Rode, Gleason et al., 2008).

Females typically den in November (Amstrup, 2003). Polar bears denning on sea ice usually select deep snow drifts adjacent to pressure ridges or jumbles of multi year ice (Durner, Amstrup, Nielson et al., 2004). The seismic survey vessel cannot operate in this kind of ice, but it is possible that the icebreaker and survey vessel may transit through or near some multi-year ice or pressure ridges during the survey. Bears that are disturbed from their dens early in the season, before they have given birth, are believed to move to a new den site fairly readily, as other bear species do (Amstrup, 1993). Bears that are disturbed from their dens early in the spring after they have given birth may lose their cubs; however, polar bears give birth in late December or early January, after the survey will be completed in the Chukchi Sea. Polar bear dens have occurred throughout the proposed survey area (USDOI, USGS, 2007). It is likely that bears are sometimes forced to locate new den sites early in the year due to storms that cause the ice to break up and re-form. Some bears may be disturbed from their dens by the icebreaker and seismic survey vessel. These bears would be likely to move to another den site. Most impacts to polar bears are likely to be limited to disturbance. To date, in-ice seismic surveys have been proposed, but have not occurred as a part of industry activities, although they have been conducted as a part of NSF research projects. Polar bear critical habitat is made up of three units, terrestrial denning habitat, barrier islands and sea-ice habitat. In-ice seismic surveys cannot be conducted near barrier islands and shorelines because the water is too shallow to safely deploy the equipment. Therefore no effects to terrestrial denning habitats or barrier islands are anticipated. In-ice seismic surveys overlaps only with sea ice. Sea ice critical habitat is made up of “Annual and perennial sea-ice habitats that serve as a platform for hunting, feeding, traveling, resting, and (to a limited extent) denning,” (75 FR 76086: Dec. 7, 2010).

Ice-breaking has been shown to result in short term openings in the pack ice. As the ice is typically subject to large scale pressure from currents, winds, or neighboring ice, in fall and winter the openings typically close quickly, most frequently within hours of ice breaker passage. If sea water temperatures fall below -1.8 degrees C (28.8 degrees F), new ice will form in the openings. Under certain wind, current, water temperature situations, the openings could persist for longer periods. Ice breaking activities associated with the proposed action would take place in fall when the sea ice is forming. The proposed action would affect relatively small areas of critical habitat at any given time, as the ice will re-freeze behind the icebreaker and survey ship within a few hours to a few days (Mahoney, 2010). No long-term or widespread effects on the areal extent and distribution of critical habitats are anticipated because the ice is likely to be constantly shifting and moving during transit. Any adverse effects from ice breaking are expected to be short term and localized. No adverse modification of critical habitat is anticipated.

5.3.1.1.5 Exploration Drilling Operations

Exploration drilling typically occurs from a drillship, jack-up rig, or an SDC in open water. Up to two drillships are anticipated to be operating simultaneously in each sea. These may drill at more than a single location in a given year. Each rig could drill up to three test wells per open water season. Exploration drilling would occur during the open water season in the OCS (> 3 miles from shore or barrier islands).

Impacts to polar bears are limited because polar bears typically remain on the sea ice during the summer open water season when drilling occurs. Some polar bears may be in the vicinity of exploration drilling activities while swimming from the sea ice to shore late in the season, but sightings of polar bears in open water areas are rare. Two drill rigs active at a time per sea during the open water season would have a relatively small footprint. Impacts to polar bears would be limited to short term disturbance of a few individuals.

Exploration drilling in the OCS would not occur in sea ice or on barrier islands or coastlines (e.g., polar bear critical habitat). Some ice management activities could occur in conjunction with

exploratory drilling should sea ice drift into the area during operations. The effects, if any, of such ice management activity would be very localized and unlikely to affect the availability of sea ice habitat for the polar bear or their primary prey (ringed and bearded seals).

5.3.1.1.6 Authorized Discharges

Operators must acquire and adhere to the terms of an NPDES permit, received from the EPA. The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

Discharges from the Proposed Action would occur during various operations, each for a period of weeks up to several months. Discharge of drilling muds and cuttings during exploration activities are not expected to have any effect on polar bears, either directly through contact or indirectly through affecting prey species. Discharges would be in the open water where cuttings would settle out on the sea floor. No impacts to polar bears or critical habitat are anticipated.

5.3.1.1.7 Oil Spills

Oil spills are accidental or unlawful events that are evaluated in BOEMRE NEPA documents according to three different size categories: small, large, and very large. In general, polar bears can be found on the pack ice of the Beaufort and Chukchi Seas, or along barrier islands and the shore during the open water season. They are less likely to be found in open water, but will swim considerable distances from ice to shore or vice versa. As sea ice breaks up in spring, polar bears follow the receding ice edge and may come ashore in late summer and fall, where they remain until the sea ice reforms in early winter. Large aggregations of polar bears may be vulnerable to a large or very large spill on Wrangel, Barter or Cross islands in late summer and fall, when they congregate in these areas. Indirect sources of mortality may occur when seals or other mammals die from oil exposure. Bears have an excellent sense of smell and will travel long distances to locate food sources. Given that polar bears have been observed chewing on oil cans and fuel bladders, as well as snow machines and, in one case, a car battery; it seems unlikely that polar bears would avoid their usual prey items due to oiling. Ingesting oiled prey could be a secondary source of impact from a spill.

Small Oil Spills

A small oil spill is defined as <1,000 bbl. The average crude-oil spill size is 3 bbl for spills <500 bbl. Small spills could occur during G&G activities or exploration drilling activities. For example, small fuel spills could occur during refueling of vessels. Typically, a seismic vessel transfer spill has been estimated to range from <1-13 bbl. The <1 bbl volume assumes that dry quick disconnect and positive pressure hoses (standard on most seismic vessels) function properly. The 13 bbl spill volume assumes spill prevention measures fail or fuel lines rupture.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum anticipated annual levels of geophysical or geological activities could range from 0 if no fuel spills occur to <9 barrels if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations for Beaufort Sea operations likely would occur at Prudhoe Bay's West Dock facility in Tuktoyuktok, Canada, or at sea with the use of fuel supply vessels. Refueling operations in the Chukchi Sea likely would occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. A ≤50 bbl spill was estimated to occur during exploration drilling operations from refueling (USDOI, MMS, 2009a, b). Polar bears are not likely to be in open water where G&G activities and exploration drilling occurs. Small spills offshore dissipate quickly (a few hours to a few days). Small spills onshore that are caused by industry are typically cleaned up completely, with oiled soil or tundra removed from the location.

Polar bears would be hazed away from active clean up efforts for the safety of personnel and bears. Some disturbance of polar bears and of habitat could occur during clean up efforts for small spills. The level of disturbance is likely to be limited to a few bears and/ or a small area. However, the effects of small-volume spills on polar bear would depend upon the location and timing of each spill, as well as the speed and success rate of clean up efforts, and of efforts to haze bears away from the spill area. If one or more small-volume spills were to occur in close proximity to Bernard Spit, Cross or Barter Island in late summer or fall, 60 bears or more could be present (Miller, Schliebe, and Proffitt, 2006).

Large Oil Spills

A large oil spill is a low-probability event that is not likely to occur during exploration or development and production. It is not a part of the Proposed Action. The potential impacts of this low-probability event are described here.

Beaufort Sea

The following large oil spill analysis presents oil weathering estimates and the OSRA model conditional and combined probabilities expressed as percent chance. Conditional probabilities assume that a large spill has occurred, and model the chance of a large oil spill contacting particular resource areas (see Appendix A). Combined probabilities model the chance of one or more large spills occurring and contacting a particular environmental resource area. The probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting the Environmental Resource Areas (ERAs) and Land Segments (LSs) or Grouped Land Segments (GLSs.) ERA locations are found in Appendix A, Maps A.1-2a through 2e and Appendix A, Maps A.1-3a through 3d. The OSRA model assumes that a large spill starts at a specific launch area or pipeline segment. The launch areas (LAs) and pipeline segments (PLs) for the Beaufort Sea area are found in Appendix A, Map A.1-4. An ERA can represent an area important to one or several species or species groups during a discrete amount of time (Table A.1-16). This section analyzes risk to polar bears and polar bear critical habitat. Oil spill impacts to ice seals, such as ringed seals, could impact polar bears by limiting prey available to them or by causing mortality from secondary contamination.

Conditional Probabilities

This section discusses the chance that a large oil spill from the Proposed Action area would contact specific ERAs that are important to polar bears. Conditional probabilities assume that a large spill has occurred, and the oil spill trajectory model simulations do not include oil spill response. During the summer season (July–September) a 1,500-barrel platform spill would cover approximately 9 km² after 3 days and 181 km² of discontinuous area after 30 days, and would oil an estimated 29 km of coastline. The same spill in winter would cover 7 km² after 3 days and 143 km² of discontinuous area after 30 days, and would oil an estimated 32 km of coastline (Appendix A, Table A.1-6.) These examples highlight the critical importance of an immediate response from on-site oil spill response personnel and equipment.

A 1,500 or a 4,600-barrel spill could contact ERAs where polar bears may be present (Appendix A, see especially Table A.1-16). Approximately 40% of a 4,600-barrel pipeline spill during the summer open water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in the fall or under ice in the winter would melt out in the following summer, potentially causing major impacts to polar bear. Approximately 69% of a 4,600-barrel pipeline spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km² (Table A.1-7).

Summer Oil Spills - Barrier Islands and Coastline. A large summer spill could impact polar bears coming ashore due to sea-ice retreat or in preparation for denning later in the fall/winter season. The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during summer, unless

otherwise specified. The particularly important areas during this time period include barrier islands along the coast as well as the coastline itself. The OSRA model estimates the chance of a large oil spill contacting the barrier islands that are important ERAs to polar bears (Table A.1-41). Barter Island (ERA95) and Cross Island (ERA93) are particularly important because of the large concentrations of polar bears that are drawn to the islands to feed on bowhead whale carcasses in fall. A large spill has a 7% chance or less of contacting Cross Island and No Name Island within 30 days. Within 360 days, the chance of contact remains at 7% or less. A summer spill has a 5% chance or less of contacting Barter Island, Bernard Spit, and Arey Island within 30 days. Within 60 days, the chance of contact remains at 5% or less. For more information see USDO, MMS (2008) Appendix A, Tables A.2-65, A.2-66, A.2-71 and A.2-72.

If groups of land segments are considered, the chance of a large spill contacting the U.S. Beaufort Sea (GLS 144) coastline within 30 days varies from <0.5% from LA25 to a high of 63% from LA4. The chance of contact is highly variable due to the effects of wind, current, and proximity to shore and depends on the location of a LA where a large spill could originate (USDO, MMS, 2008, Appendix A Table A.2-89, Appendix A, Maps A.1-3d and A.1-4). Within 360 days, the estimated chance of contact increases to a low of 23% from LA25 to a high of 72% from LAs 2 and 4 (USDO, MMS, 2008, Table A.2-95). The chance of contact from a large spill originating at a PL reaching the U.S. Beaufort Sea coastline within 30 days ranges from 1% from PL16 to a high of 59% from PL8 (USDO, MMS, 2008, Table A.2-90). Within 360 days, the estimated chance of a large spill contacting the coastline ranges from 36% from PL16 to 69% from PL8 (USDO, MMS, 2008, Table A.2-96).

The estimated chance that a large oil spill originating at a LA would contact the shoreline of ANWR, also an important polar bear-denning habitat, within 30 days ranges from <0.5% from 14 launch areas to a high of 51% from LA18. Within 360 days, this rises to a range of 1-53%. The estimated chance that a large oil spill originating at a pipeline segment would contact the shoreline of ANWR within 30 days ranges from <0.5% from nine PLs to a high of 45% from PL14. Within 360 days, the chance of a large spill contacting from all PLs ranges from 1-49% (USDO, MMS, 2008, Appendix A, Tables A.2-89, A.2-90, A.2-95, and A.2-96).

Winter Oil Spills - Barrier Islands and Coastline. The OSRA model estimates the chance of a large oil spill during winter (October–June) contacting the barrier islands that are important ERAs to polar bears (Table A.1-42). The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during winter, unless otherwise specified. A large spill has a 1% chance or less of contacting Cross Island and No Name Island within 30 days. Within 360 days, the chance of contact remains at 1% or less. A large spill has a <0.5% chance of contacting Barter Island, Bernard Spit, and Arey Island within 30 days. Within 360 days the chance of contact remains at 1% or less. For more information, see Appendix A, Tables A.2-113, A.2-114, A.2-119 and A.2-120.

If groups of LSs are considered, the chance of contact from a large spill at launch areas reaching the U.S. Beaufort Sea coastline (GLS 144) within 30 days ranges from a low of <0.5% at three LAs to a high of 14% at LA18 (Table A.2-137, Maps A.1-3d and A.1-4). The chance of contact from a large spill originating at a PL reaching the U.S. Beaufort Sea coastline within 30 days ranges from <0.5% at PL16 to a high of 12% at PL14. The estimated chance that a large oil spill originating at any LA contacts the shoreline of ANWR (GLS 138) within 30 days ranges from a low of <0.5% from seven LAs to a high of 14% from LA18. The chance that a large oil spill originating at a PL would contact the shoreline of ANWR within 30 days ranges from a low of <0.5% from two PLs to a high of 12% from PL14 (Appendix A, Table A.2-137 and A.2-138).

Combined Probabilities. Combined probabilities differ from conditional probabilities in that there is no assumption that a spill has occurred. Instead, combined probabilities reflect the chance of one or more large spills occurring and contacting any portion of a particular resource area. Combined probabilities do not factor in any cleanup efforts. For more background, see Appendix A, Section 4.3.

The OSRA model estimates the chance of one or more large spill ($\geq 1,000$ bbl) occurring and contacting any portion of Point Barrow; the Plover area; or Thetis, Jones, Cottle, or Return islands is $<0.5\%$ within 3 days to within 10 days, then it increases to 1% and remains at 1% from within 30 days through 360 days. The combined probabilities of one or more large spills ($\geq 1,000$ bbl) occurring and contacting any portion of Maguire, Flaxman, or Barrier island is $<0.5\%$ within 3 days until within 180 days; the percent chance rises to 1% within 360 days. There is a $<0.5\%$ chance of a spill occurring and contacting Cross, No Name, Arey, or Barter islands or Bernard Spit from 3 days after a spill through 360 days after a spill. The combined probability of one or more large spills occurring and contacting the coastline of ANWR after a spill is 1% within 10–30 days, 2% within 60 days, 3% within 180 days, and 4% within 360 days.

Chukchi Sea

Conditional Probabilities

This section discusses the chance that a large oil spill from the Chukchi Sea lease sale area would contact specific environmental resource areas that are important to polar bears, including polar bear critical habitat. Conditional probabilities assume that a spill has occurred; oil spill response is not simulated in the oil spill trajectory model.

A large spill occurring during the summer season (between June and October) of 1,500-barrels originating from a platform would cover approximately 29 km² after 3 days and 577 km² of discontinuous area after 30 days, and would oil an estimated 25 km of coastline. A winter spill of the same size from a platform would cover 10 km² after 3 days and 188 km² of discontinuous area after 30 days, and would oil an estimated 30 km of coastline (Appendix A, Table A.1-11). A spill occurring during the summer season (between June and October) of 4,600-barrels originating from a pipeline would cover approximately 51 km² after 3 days and 1008 km² of discontinuous area after 30 days, and would oil an estimated 42 km of coastline. A winter spill of the same size from a platform would cover 16 km² after 3 days and 332 km² of discontinuous area after 30 days, and would oil an estimated 51 km of coastline (Appendix A, Table A.1-12). These examples highlight the critical importance of an immediate response from on-site oil spill response personnel and equipment.

A 1,500 or a 4,600-barrel spill could contact environmental resource areas where polar bears may be present (Appendix A, see especially Table A.1-17). Approximately 44% of a 4,600-barrel pipeline spill during the summer open water period would remain after 30 days, covering a discontinuous area of 1008 km². A spill during broken ice in the fall or under ice in the winter would melt out in the following summer, potentially causing major impacts to polar bear. Approximately 55% of a 4,600-barrel pipeline spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 332 km² (Tables A.1-11 and A.1-12).

The OSRA model calculates conditional probabilities (expressed as a percent chance) of a large spill contacting identified polar bear habitats (ERA polygons, LS or GLS). Conditional probabilities are based on the assumption that a large spill has occurred (for further explanation, see Appendix A.) For a map of the hypothetical platform locations (launch areas) and the hypothetical pipeline routes that the model uses for the oil spill trajectory analysis, see Appendix A Map A.1-5. There are 15 Launch Areas (LAs) and 11 pipeline segments (PLs) considered in the model.

Summer Oil Spills - Islands, Barrier Islands, and Coastline. A summer spill could impact polar bears coming ashore due to sea-ice retreat or in preparation for denning later in the fall/winter season. The areas in the Chukchi Sea that would be particularly important include Wrangel Island, Herald Island, and Ostrov Kolyuchin (Kolyuchin Spit), areas where polar bears come ashore to feed on walrus carcasses and to den. Polar bear dens also can be found along both the U.S. and Russian coasts of the Chukchi Sea (USDOI, USGS, 2007). A large spill in the Chukchi Sea could impact the coastline of the Beaufort Sea, as well as the barrier islands near Point Barrow and Barrow. In winter, polar bears range throughout the ice-covered waters of the Chukchi Sea. They may be found near polynyas and open lead systems, where they prey on seals.

The OSRA model estimates the chance of a summer oil spill contacting the ERAs and coastal areas that are important resource areas to polar bears (summarized in Table A.1-43). Wrangel Island and Herald Island are particularly important because of the large numbers of polar bears that are drawn to the islands to den and to feed on walrus in late summer and fall. A summer large spill has a 2% chance or less of contacting Wrangel Island or Ostrov Kolyuchin and a 1% chance or less of contacting Herald Island within 30 days, for all potential LAs and pipeline spills. There is no difference within 360 days; the percent chance remains at 1% or 2%. A summer spill has a 3% chance or less of contacting Point Barrow or the Plover Islands within 30, for all potential LAs and pipeline spills. The percent chance rises to 7% within 360 days. For the Barrow, Browerville, Elson Lagoon area, the percent chance of contact from a summer spill is 8% within 30 days and 13% within 360 days. For more information see Appendix A, Tables A.3-33, A.3-36, A.3-39, A.3-42.

If GLSs are considered, the chance of contact from a summer spill originating at a LA or PL in the Chukchi Sea lease-sale area reaching the U.S. Beaufort Sea coastline (GLS 144) within 30 days varies from <0.5% at 18 LAs and PLs to a high of 10% at LA13. The percent chance of contact is variable due to the effects of wind, current, and proximity to shore and depends on the LA or PL where the spill originates (Table A.3-45, Maps A.1-3d and A.1-5). Within 360 days, the percent chance remains <0.5% at 10 LAs and PLs, and rises to a high of 23% at LA8 (Table A.1-43). The chance of contact from a summer spill originating at a LA or PL in the Chukchi Sea lease-sale area reaching the U.S. Chukchi Sea coastline (GLS 143) within 30 days varies from <0.5-22% (LA 11) for LAs and from <0.5% (PLs 4 and 7) to 33% (PL 9) and 35% (PL 6) for PLs. Within 60 days, the percent chance rises to 31% (LA 11), 42% (PL 9), and 43% (PL 6). The chance of contact from a summer spill originating at a LA or PL in the Chukchi Sea lease-sale area reaching the Russian Chukchi Sea coastline (GLS 142) within 30 days varies from <0.5% at 12 LAs and PLs to a high of 20% at LA9 and 20% at PL1 (USDOI, MMS, 2008, Table A.3-45, Appendix A, Maps A.1-3d and A.1-5). Within 360 days, the percent chance remains at a low of 1% at 8 LAs and PLs, and remains at a high of 20% at LA9 and PL1 (USDOI, MMS, 2008, Table A.3-48.)

The percent chance that a large oil spill originating at any LA or PL in the Chukchi Sea lease-sale area would contact the Chukchi Sea spring lead system is <0.5-14% within 30 days, and the percent chance remains the same within 360 days. The percent chance that a large oil spill originating at any LA or PL in the Proposed Action area would contact the Chukchi Sea polynyas, important polar bear foraging habitat, within 30 days of a spill ranges from <0.5% to highs of 84% at LA11 and 82% at PL5. Within 360 days, this rises to a range of <0.5-85% at LA11 and 82% at PL5 (USDOI, MMS, 2008, Tables A.3-33 and A.3-36).

Winter Oil Spills - Barrier Islands and Coastline. A large spill during winter could impact polar bears on nearshore or offshore ice. A large spill in winter would be difficult to clean up, and oil could become entrained in the ice, melting out in spring and contacting lead systems and coastal areas. The areas in the Chukchi Sea that would be particularly important include Wrangel Island, Herald Island, and Ostrov Kolyuchin (Kolyuchin Spit), areas where large concentrations of polar bears come ashore to feed on walrus carcasses and to den. Polar bear dens also can be found along both the U.S. and Russian coasts of the Chukchi Sea (USDOI, USGS, 2007). A large spill in the Chukchi Sea could impact the U.S. and Russian coastlines of the Chukchi Sea, the coastline of the Beaufort Sea, as well as the barrier islands near Point Barrow and Barrow. In winter, polar bears range throughout the ice-covered waters of the Chukchi Sea. They may be found near polynyas and open lead systems where they prey on seals.

The OSRA model estimates the chance of a large winter oil spill contacting the ERAs and coastal areas that are important resource areas to polar bears. This information is summarized in Table A.1-44. A winter spill has a <0.5% chance of contacting Wrangel Island, Herald Island, or Ostrov Kolyuchin 30 days after a spill and a <0.5-1% chance of contacting these areas 360 days after a spill, for all potential LAs and pipeline spills. A winter spill has a <0.5% chance of contacting Point Barrow or the Plover Islands 30 days after a spill for all potential LAs and pipeline spills. The percent

chance rises to <0.5-3% at 360 days after a spill. For the Barrow, Browerville, Elson Lagoon area, the percent chance of contact from a winter spill is <0.5-2% at 30 days after a large spill and <0.5-16% at 360 days after a spill. For more information, see Appendix A, Tables A.3-57 and A.3-60.

If GLSs are considered, the chance of contact from a winter spill originating at a LA or PL in the Chukchi Sea lease-sale area reaching the U.S. Beaufort Sea coastline (GLS 144) within 30 days varies from <0.5-1%. After 360 days, the percent chance of contact ranges from <0.5-11%. The chance of contact from a winter spill originating in the Chukchi Sea Proposed Action area reaching the U.S. Chukchi Sea coastline (GLS 143) within 30 days varies from <0.5-13% (LA 10) and from <0.5% (PLs 4, 7, and 10) to 21% (PL 6). After 360 days, the percent chance ranges from <0.5-28% for LAs and from 2-38% for PLs. The chance of contact from a winter spill originating in the Chukchi Sea lease-sale area reaching the Russian Chukchi Sea coastline (GLS 142) within 30 days varies from <0.5-8% for LAs and PLs. Within 360 days, the percent chance remains <0.5-8% for LAs and from <0.5-9% for PLs. The chance of a large spill contacting a resource area is variable due to the effects of wind, current, ice and proximity to shore and depends on the LA or PL where the spill originates (Tables A.3-69 and A.3-72, Maps A.1-3d and A.1-5).

The percent chance that a large oil spill originating in winter at any LA in the Chukchi Sea Proposed Action area would contact the Chukchi Sea spring lead system is <0.5-16% within 30 days and <0.5-23% within 360 days. The percent chance that a large oil spill originating in winter at a PL in the Proposed Action area would contact the Chukchi Sea spring lead system is <0.5-26% within 30 days and <0.5-35% within 360 days. The percent chance that an oil spill originating at any LA or PL would contact the Chukchi Sea polynya areas within 30 days ranges from <0.5-18% at LAs and from <0.5-32% at PLs. Within 360 days, this rises to a range of <0.5-33% at LAs and <0.5-39% at PLs (USDOI, MMS, 2008, Appendix A, Tables A.3-57 and A.3-60).

Combined Probabilities. Combined probabilities differ from conditional probabilities in that there is no assumption that a large spill has occurred. Instead, combined probabilities reflect the percent chance of a large spill occurring and contacting any portion of a particular resource. Combined probabilities do not factor in any cleanup efforts. For more background, see Appendix A, Section 4.3.

The combined probabilities of one or more large spills ($\geq 1,000$ bbl) occurring and an contacting any portion of Wrangel Island, Herald Island, Ostrov Kolyuchin, Barrow, Browerville, or Elson Lagoon is <0.5% within 3 days up to within 360 days. The model does not estimate the percent chance of contact beyond 360 days. The combined probabilities of one or more large spills occurring and contacting any portion of the Chukchi Sea spring lead system or the Wainwright area polynya system (also identified as a subsistence area) is 5% within 30 days and 7% within 360 days. The combined probabilities of one or more large spills occurring and contacting any portion of the Point Lay area polynya system (also identified as a subsistence area) is 5% within 30 days and 8% within 360 days. The combined probabilities of one or more large spills occurring and contacting any portion of Point Barrow or the Plover Islands is <0.5% within 30 days and 1% within 360 days.

For GLSs, the combined probabilities of one or more large spills occurring and contacting any portion of the Russian Chukchi coastline is 1% within 30 days and 360 days. The combined probabilities of one or more large spills occurring and contacting any portion of the U. S. Beaufort Sea coastline is <0.5% within 30 days and 1% within 360 days. The combined probabilities of one or more large spills occurring and contacting any portion of the U. S. Chukchi coastline is 6% within 30 days and 11% within 360 days (USDOI, MMS, 2008, Appendix A; Tables A.3-79, A.3-80, and A.3-82). The combined probabilities do not factor in any oil-spill-cleanup efforts and do not differentiate between the amounts of oil contacting the coastline.

Effects from Oil Spill Response Activities

Spill response and clean up activities would involve large number of boats of various sizes, skimmers, airplanes and helicopters. In-situ burning and corralling oil with boom material, or booming off

sensitive nearshore habitats may occur. Although the U.S. Coast Guard (USCG) has not previously approved the use of dispersants in the Arctic, their use in the event of a large oil spill is foreseeable.

In the initial aftermath of a spill, activity would be concentrated in the immediate area of the spilled oil. Polar bears would not be found in large numbers in an open water environment and would likely avoid the area due to the large amount of noise and activity. This may reduce the likelihood that they would be immediately exposed to oil or be exposed to PAHs which tend to evaporate relatively quickly (within a few days, unless frozen into ice). Gas (primarily methane and ethane) would quickly dissipate into the atmosphere at the spill site and polar bears are not likely to be exposed to gas in the event of an explosion and spill. Immediate responses, in addition to seeking to control the well and stop the flow of oil, may include attempts to cap the flow or repair the rupture. In-situ burning has been shown to be very effective with freshly spilled oil, but the oil becomes more difficult to ignite as it ages and the aromatic hydrocarbons burn or evaporate. In-situ burning would release soot and other pollutants into the air, if the soot is carried by air currents to shore or to ice floes, polar bears may be exposed to enough smoke and soot to suffer respiratory effects, or may have their coats soiled by pollutants, which they then might ingest while grooming.

As the spill response continues, the oil (and thus the response) will become spread out over a larger area. The amount of oil being discharged daily would decrease as the pressure remaining in the well decreases. BOEMRE has estimated that the flow of oil would decrease from a high of 60,000 bbls/day to a little over 20,000 bbls/day over a 74-day uncontrolled well incident. Depending upon the location of the spill site and the time of the spill, BOEMRE estimates that a discontinuous area of 162,200 square kilometers (km^2) to 547,600 km^2 would be contacted by oil. As the spill continues, clean up efforts would likely focus on the spill site, villages and areas deemed to be critically important to fish or wildlife. If the spill begins late in the open water drilling season (September to October), then the longer the spill goes on, the more likely it becomes that polar bears will encounter oil and/or disturbance from clean up efforts. In recent years, more polar bears have congregated on shore while waiting for the sea ice to form. Large aggregations of bears from the SBS stock now occur near Cross Island and Barter Island, where bears scavenge on whale carcasses. Wrangel Island also has large numbers of bears from the CBS stock. Were oil to contact one of these aggregations of bears, it would constitute a significant impact to the SBS or CBS stock of polar bears.

The next phase after the large oil spill has been stopped would involve cleaning of any remaining oil that can be located. Clean up efforts could focus on oiled shoreline, and hot washing methods or dispersants could be used. While dispersants can be effective at breaking oil up into smaller droplets, they also contain toxic chemicals such as hydrocarbon solvents and glycols. Dispersants may cause skin irritations, respiratory impacts or impacts to sensitive tissues around the eyes, nose or mouth. Polar bears may be drawn to the area by human activity or carcasses, or they may avoid the areas. Additional human-polar bear interactions could result in an increase in polar bear take through hazing or in defense of human life. It may be possible in some instances to sedate and capture oiled polar bears, and to clean their coats. However, if these bears had already ingested oil, they would not be likely to survive. A study of polar bear reactions to snowmobiles found sex and age class differences in reaction. Females with cubs and single smaller bears reacted more strongly by avoidance than did adult males or single adult females (Anderson and Aars, 2008). Similarly, anecdotal information from ice breakers suggests that bears are likely to move away from ice breaking activities unless they are actively feeding.

The clean up process may be continued the year following the spill. Oil frozen in ice over winter would melt out in the spring, through brine channels and into leads and polynyas (Fingas and Hollebone, 2003). Skimmers and other methods may be used to try to capture this remaining oil the spring/summer following the spill. This could lead to additional disturbance to polar bears in the leads and polynyas where they tend to focus their hunting efforts. Polar bears may also be exposed to oil in the leads and open water between floes or on the floes themselves depending upon the distribution of the remaining oil once it melts out of the winter ice.

Long Term Recovery

After clean up efforts have ceased, the remaining oil will continue to weather and be subject to microbial degradation. This process is likely to be very slow in Arctic waters. Oil that has been suspended in the water column or in the sediment may continue to be ingested by the benthic organisms that bearded seals and walrus prey upon. Ringed seals are less likely to accumulate hydrocarbons through the fish that they eat (Geraci and St. Aubin, 1990). Polar bears that are eating bearded seals or walrus may continue to be exposed to hydrocarbons through their prey, which may lead to reduced fitness over time.

Damage assessment studies will occur as a part of the natural resource damage assessment process (NRDA). Depending upon the types of studies conducted, some may lead to increased disturbance by adding additional boat, plane and shoreline traffic to the Chukchi Sea.

Conclusion

Increasing trends in polar bear use of terrestrial habitat in the fall are likely to continue, as sea-ice conditions continue to change. BOEMRE realizes that some OCS operations might pose a relatively high chance of contacting polar bear aggregations, depending on their geographic location and if a spill occurred and, therefore, to the polar bear population as a whole. In March 2006, more than 5,053-bbl (212,252 gal) of oil spilled onto the tundra on the North Slope as a result of a leak in a corroded pipeline that went undetected for an extended length of time (State of Alaska, DEC, 2008). As demonstrated by this spill, small, chronic leaks in underwater pipelines could result in large volumes of oil being released under water without detection. If such an event were to occur in offshore waters, there could be major impacts to the polar bear population. If such a spill occurred during winter, the release of oil trapped under the ice during spring breakup would be equivalent to the catastrophic release of the same amount of oil (Amstrup, Durner, and McDonald, 2000). The continued use of new technology, such as the LEOS leak-detection system, can greatly enhance the ability to detect small leaks so they do not become large spills over time. BOEMRE regulations require spill prevention and equipment monitoring.

5.3.2 Direct and Indirect Effects of Development and Production on Marine Mammals

Development and production logically follow if a leaseholder finds an economically-developable field. Development activities include the construction or installation of a production facility and necessary pipelines that would convey oil or gas to existing infrastructure. Vessel and aircraft traffic, seismic surveys, drilling activities, and discharges have been discussed previously in Sections 5.2.1 and 5.2.2. Production activities are those that make use of the developments; the drilling of production wells and the operation of pump stations and other facilities that move the oil/gas to existing infrastructure.

If development and production proceed after exploration, the operator must submit a Development and Production Plan, which would be evaluated to ensure compliance with NEPA; additional consultation under the ESA would be required. The purpose of this section is to describe the potential effects of a “single and complete project” that could arise from the leases issued under the Arctic Region OCS program as it is currently understood. Subsequent evaluations would be based on site-specific information and additional details provided through the Development and Production Plan process.

Effects from Facility Construction

A production facility and new subsea pipelines are the largest components that would need to be constructed to support getting product to existing infrastructure. Construction could occur year round. Platform construction would produce lower energy localized noise from equipment operation, generators, etc. The sounds from these activities would not be likely to travel as far as sound from

2D/3D or site clearance seismic surveys. Similarly, pipeline construction would involve a slow-moving sound source that would have a localized, low energy noise footprint that is smaller than 2D/3D or site clearance seismic surveys.

Effects of Facility Operations

Once a development facility is constructed, routine production operations would begin. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted. The specific potential effects would depend on the type of facility being proposed, its location, and the equipment being used (i.e., pumps, motors, etc.). For example, a gravel island facility in shallow water would likely generate less underwater noise than a free-standing facility in deeper water.

5.3.2.1 Direct and Indirect Effects to Polar Bears and Polar Bear Critical Habitat From Development and Production Activities

The types of impacts from development and production activities are similar to those from exploration. The primary impacts would be disturbance from vessel traffic, aircraft traffic, and the platform or production facility site itself. During construction, activities such as pile driving could occur. The footprint of the facility would exclude that area as habitat for foraging or denning in the foreseeable future. An oil spill that occurred during production would have the same impacts as a spill that occurred during exploration.

Typical activities that might occur include: weekly or bi-weekly aerial surveys to inspect pipelines for leaks or spills, and helicopter traffic to transport crew and materials to and from the facility. Recommended flight corridors and altitude restrictions would be maintained.

Estimates of the types of activity that might occur at a production facility are based on the Northstar facility, which is currently the only development accessing oil from the OCS. The following information is based on Northstar: During the open water period, there are 100-200 helicopter round trips, 350-500 hovercraft round trips, 40-50 tug and barge trips, and 50-150 Alaska Clean Seas Bay-class boat round trips between West Dock and Northstar. The number of trips to and from the island varies depending upon the level of construction or repair planned for that open water season. Annual repair activities may consist of removing damaged concrete blocks, installing a new layer of filter fabric, installing gravel bags of various sizes to build up and stabilize the subgrade, installing another layer of filter fabric, overlaying geogrid to reduce the susceptibility of the fabric to abrasion, and installing the concrete block armor. Vibratory or impact pile driving activities may also take place in some years.

During the ice-season, one ice road connecting Northstar to the mainland near West Dock is built. The ice road is approximately 11-15 km in length. Hagglunds tracked vehicles make approximately 40 round trips between West Dock and Northstar Island and a hovercraft makes approximately 575 round trips during the ice season.

Some small spills have occurred; for example, there were 25 reportable Northstar related spills during 2006-2007. Material spilled included drilling mud, corrosion inhibitor, sewage, methanol, motor oil, diesel fuel, hydraulic fluid, lube oil, and propylene glycol. All spilled material was contained and cleaned up. Contaminated snow, ice, and gravel were removed with various types of equipment, hand tools, and absorbents. All the contaminated materials were recovered from the ice and water surface. During 2008-2009, there were nine reportable Northstar-related spills. Two of the nine reportable spills reached Beaufort Sea water or ice. The contaminated material was recovered completely. Materials that reached Beaufort Sea water or ice included power steering fluid and hydraulic fluid. Material from the seven remaining spills did not reach the Beaufort Sea or sea ice. Contaminated snow, ice, and gravel were removed with various types of equipment and sorbents. BOEMRE estimates that a similar level of small spills will continue to occur.

Site monitoring conducted for marine mammals includes aerial surveys, acoustic buoy deployment and monitoring, and site-based visual monitoring. Few marine mammals are observed from Northstar; typically, a few seals and an occasional polar bear are observed over the course of each year. From 2006-2009, there was no evidence, or reason to suspect, that any marine mammals were killed or injured by Northstar related activities. In general, no activities are conducted that could expose polar bears to underwater sound levels greater than 180/190 dB (re 1 microPa @1 m). Polar bears are typically hazed away from facilities for the protection of the bears and of humans. Since the MMPA was passed in 1972, there have been few polar bears killed during industry activities

5.3.3 Cumulative Effects on Marine Mammals

Reasonably Certain Future Events

Cumulative effects are the combination of past, existing and future activities that are reasonably certain to occur in the Arctic Region OCS. These may be dynamic or stable, and localized or widespread. The following are the primary factors contributing to cumulative effects in the Arctic Region OCS.

5.3.3.1 Cumulative Effects on Polar Bear and Polar Bear Critical Habitat

Climate Change. The primary factor of concern for the continued existence of healthy polar bear populations throughout their range is decreasing sea ice due to climactic changes. SBS and CBS polar bears spend most of their time on the pack ice during the open water season. As pack ice decreases, the seasonal ice edge moves further north off of the continental shelf over waters that are less productive and less inhabited by ringed or bearded seals (the polar bear's principle prey items). Polar bears may spend longer time periods fasting on shore or on ice. Polar bears may also be forced to swim longer distances between shore and the retreating ice edge, increasing energy expenditures and decreasing both fitness and survival rates. Impacts to critical habitat include erosion of barrier islands and shorelines due to an increase in the open water season which results in more large storms. Sea ice is also in decline with primary effects on multi-year ice.

Subsistence hunting. The primary source of direct mortality to polar bears is take by man. Polar bears are harvested for subsistence purposes and killed in defense of human life when they enter villages or otherwise come into contact with humans. The current level of subsistence take is believed to be at or above the current estimates of PBR for the SBS and CBS sub-populations. Available evidence indicates that subsistence hunting can cause disturbance, changes in behavior, and temporary effects on habitat use, including migration paths.

Research Activities. There are several active ongoing research programs studying the SBS and / or CBS sub populations of polar bears, which include the darting and handling of polar bears. Effects from research are generally limited to temporary disturbance of individual bears. This may cause some limited energy expenditures for individual bears and possibly increase their avoidance reactions to aircraft over time. Additional research programs using icebreakers to access study sites (particularly in spring) may have some short term impact to sea-ice habitat. The spatial extent of these effects is limited to relatively small areas when compared to the available habitat.

Offshore oil and gas exploration. Noise and disturbance from oil and gas exploration and development activities on shore or near shore may have localized, short-term adverse effects, but no lasting population-level adverse effect on polar bears have been identified. There is no indication that human activities have caused long-term displacement of polar bears. Offshore exploration primarily occurs during the open water season and is not likely to impact polar bears which tend not to use open water habitats.

Discharges. Accidental fuel spills have occurred historically in the Arctic Region OCS without apparent impacts to polar bears. Due primarily to increased concentrations of bears on parts of the coast, the relative oil spill risk to the population may be increasing. Fuel spills and discharges of other

contaminants may occur from vessels transiting the Arctic (cargo ships, barges, USCG vessels, industry vessels, and research vessels). Polar bears may avoid the noise and disturbance of vessels engaged in response and cleanup activities, or be drawn to the area by curiosity. To date, impacts to polar bears and critical habitat from spills or discharges have been negligible.

Summary: The Proposed Action is likely to contribute to cumulative effects on polar bears in the Arctic Region OCS through short term disturbances of a few individual bears. Impacts to critical habitat from the proposed action are limited to temporary effects from icebreakers over a small part of the extent of sea-ice critical habitat. When considered collectively with other activities, the amount of disturbance or “take” is small. Some polar bear populations may already be in decline or decreasing in fitness due to the impacts of a changing climate. Critical habitat, particularly sea ice, is also declining. The Proposed action neither adds to nor diminishes these ongoing trends. Hunting pressure, loss of sea ice and climate change, and the expansion of commercial activities have potential to impact polar bears and polar bear critical habitat. Combined, these factors present challenges for management of polar bears in Alaska. The success of future management efforts will rely in part on continued investments in research investigating population status and trends and habitat use patterns. The effectiveness of various mitigation measures and management actions will need to be continually evaluated through monitoring programs.

5.3.4 Determination of Effects on Marine Mammals

The purpose of this Biological Evaluation is to determine the effects of the Proposed Action. The effects of the action on threatened or endangered under Section 7 of the Endangered Species Act species are considered along with the environmental baseline (Section 4.0) and predicted cumulative effects (Section 5.4). This section considers the following categories.

- The proposed actions would have no effect on the listed species,
- The proposed actions may affect the listed species. Two categories:
 - The proposed action is likely to adversely affect the listed species.
 - The proposed action is not likely to adversely affect the listed species.

It is determined through this biological evaluation that the proposed exploration and development and production of federal leases on the Chukchi Sea and Beaufort Sea OCS will likely have the following effect on threatened or endangered marine mammals:

5.3.4.1 Polar Bear and Polar Bear Critical Habitat

The Proposed Action is likely to result in adverse effects to, but is not likely to jeopardize the continued existence of the polar bear or result in adverse modification of critical habitat.

Activities associated with development and production would likely occur at lower levels than those for exploration. Duration of development activity is likely to span a period of several years, if production occurs, a production site may be active for several decades. Based on current exploration activities and a hypothetical development and production scenario and the current status of the polar bear, these activities are likely to result in adverse effects to, but are not likely to jeopardize the continued existence of, the polar bear. There is a reasonable likelihood that the entire action would not violate Section 7(a)(2). Further incremental consultation would be necessary at the time development and production plans are proposed, and more site specific information is available.

5.4 Effects Analysis for Threatened and Endangered Birds

Summary. In the following analysis, BOEMRE determined that there likely would be few direct or indirect effects if the Proposed Action were implemented—there would be a negligible level of effect from vessel presence and noise, aircraft presence and noise, seismic airgun noise, petroleum spills, increased bird predator populations, subsistence hunting, habitat loss, and a minor level of effect from collisions with structures. While the greatest potential for a major level of effect is associated with

continuing physical changes in the Arctic environment, the Proposed Action would not result in a direct effect on this impact category.

In the cumulative effects analysis BOEMRE describes the anticipated effects to threatened and endangered birds from a variety of existing sources in the project area and then combine these effects with anticipated effects from the Proposed Action. Mitigation measures imposed on existing and future exploration and development activities avoid or minimize adverse effects to ESA-listed birds in OCS areas of the Beaufort and Chukchi seas. BOEMRE-authorized actions in the OCS could result in a small incremental increase in or longer duration of some activities, the total effect would be proportionately lower when compared to similar, but unrestricted activities in the area. The greatest potential for a major level of cumulative effect is associated with continuing physical changes in the Arctic environment.

Threatened and endangered birds in the Chukchi and Beaufort seas include the Steller's eider (threatened) and spectacled eider (threatened). The Kittlitz's murrelet and the yellow-billed loon are candidate species (Listing Priority Number 2 and 8, respectively). The FWS defines a candidate species as: "...one for which we have sufficient information to prepare a proposed rule to list it, because it is in danger of extinction or likely to become endangered within the foreseeable future throughout all or a significant portion of its range." BOEMRE included the Kittlitz's murrelet and yellow-billed loon because they may be proposed for listing or be listed in the foreseeable future. BOEMRE often refers to these species collectively as ESA-listed or ESA-protected birds.

5.4.1 Exploration

5.4.1.1 Background on Effects

5.4.1.1.1 Vessel Traffic

How waterfowl and marine birds respond to disturbances can vary widely depending on the species, time of year, disturbance source, habituation, and other factors (Fox and Madsen, 1997). It seems that in some species of waterfowl, the distance at which disturbances will be tolerated varies depending on flock size, because larger flocks react at greater distances than smaller flocks (Madsen, 1985). There is an energetic cost to moving away from a disturbance as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Vessels might disturb waterfowl and marine birds that are foraging or resting at sea or, in the case of a few species, molting at sea.

Disturbance is most likely to have an impact during those periods of the annual cycle when birds have difficulty in meeting their daily energy requirements, especially when food intake needs to be high to enable birds to build up nutrient reserves in advance of periods of high demand. Frequent disturbance could result in energy expenditures that prolong the molt beyond the ice-free period or decrease the amount of stored energy reserves available for winter survival. The condition of some species during the winter period likely influences subsequent reproduction. Madsen (1994) studied the long-term effects of hunting disturbance on pink-footed geese (*Anser brachyrhynchus*) and found that geese that had used undisturbed sites reproduced better than geese from disturbed sites.

The overall effect on some bird populations includes the periodic interruption of migrating post-breeding and molting eiders. For example, most spectacled eiders breeding on the Arctic Coastal Plain (ACP) make regular use of the lease-sale areas, and each sex/age cohort could be affected differently, depending on time and location. In the most extreme case, an estimated 33,200 spectacled eiders have been counted in the Ledyard Bay Critical Habitat Unit (LBCHU) during the latter portion of the molting season. As most of these eiders are believed to be successfully breeding females and their hatch-year broods, even a seemingly trivial incremental degree of adverse effect to individual fitness (caused by chronic vessel disturbance) applied to such a large number of birds could result in decreased winter survival with resultant decreased population size, productivity, and recruitment.

There are a few notable differences in how birds could be affected in the Chukchi Sea that warrant special emphasis. Nearshore areas of the Chukchi Sea often are some of the first ice-free areas available to spring migrants. These open-water areas (sometimes referred to as polynyas or the spring lead system) can support dense concentrations of birds as migrants continue to arrive but cannot continue, because eastern destinations are still snow or ice covered. Vessel disturbance is most likely to have an impact during those periods of the annual cycle when birds have difficulty in meeting their daily energy requirements, especially when food intake needs to be high to enable birds to build up nutrient reserves in advance of periods of high demand, such as egg-laying. As these birds staging in the polynyas are returning to their breeding grounds, changes in their fitness or nutritional status could affect future reproductive efforts.

A similar situation occurs during the post-breeding period, except that the migration for some species is phased with males departing for molting areas first, followed by females that have lost their nests, and finally by successfully breeding females and their broods. The flow of birds into the molting areas takes place over an extended period of time. While there is a benefit of not having the entire population concentrated in one particular area, such as may occur in the spring lead system, certain cohorts (such as a years' successful hens) could be in one area at one time. While concentrations of molting eiders in the LBCHU have some ability to slowly move around in ice-free waters, this movement comes at an energetic cost, and they may be displaced to areas of lower productivity.

5.4.1.1.2 Aircraft Traffic

Low-level helicopter or other aircraft traffic could adversely affect birds on the North Slope and coastal areas by: (1) displacing adults and/or broods from preferred habitats during pre-nesting, nesting, and brood-rearing and migration; (2) displacing females from nests, exposing eggs or small young to inclement weather or predators; and (3) reducing foraging efficiency and feeding time. Aircraft flights could force large numbers of birds to interrupt feeding to either dive or move away from an important foraging site to a site of lower prey availability in response to the approaching aircraft. Negative effects could result if an expenditure of energy during a physiologically-demanding period of egg production, brood-rearing, or feather growth and the accumulation of energy reserves needed for later migration to wintering areas. Ward and Sharp (1974) assessed the impacts of helicopter overflights on molting long-tailed ducks and surf scoters at Herschel Island, Yukon Territory in August 1973. They found that all but 8% of long-tailed ducks and 2% of surf scoters reacted to the helicopter disturbance. While most molting ducks swam away from the helicopter, the rest that reacted dove underwater in response to helicopter approach. The reaction of these sea ducks to low-level flights indicated an interruption of normal behavior (such as cessation of foraging or sleeping) or displacement from foraging areas.

Lehnhausen and Quinlan (1981) observed low-flying aircraft disturbing common eider nesting colonies on barrier islands, flushing birds off their nests in "mass panic flights." The authors speculate that gulls and jaegers ("...constantly flying over [the colony]") preyed on the nests while the adults are away, resulting in decreased nesting success. Low-flying aircraft also could impact sensitive species, such as brant feeding and resting in coastal salt marshes or long-tailed ducks molting in coastal lagoons (Lehnhausen and Quinlan, 1981).

Helicopter and fixed-wing aircraft accounted for 67% and 33% of all flyover disturbance at a murre colony in coastal California (1997-1999; Rojek, Parker, Carter et al., 2007). These disturbances resulted in flushing of adult common murres. Flushing during incubation or chick-rearing periods can lead to egg or chick loss because of displacement from the breeding site, egg breakage or depredation by avian predators such as ravens or gulls. Rojek, Parker, Carter et al. (2007) suggested that murres are more prone to flushing in the pre-egg and early egg-laying periods than after egg-laying is well under way.

The behavioral response of eiders to low-level aircraft flights is variable; some spectacled eiders nest and rear broods near the Deadhorse airport, indicating that some individuals tolerate frequent aircraft

noise. Individual tolerances are expected to vary, however, and the intensity of disturbance, in most cases, would be less than that experienced by birds at the Deadhorse airport. Some birds may be displaced, with unknown physiological and reproductive consequences.

Disturbance to nesting spectacled and Steller's eiders is probably limited due to their extremely low densities across the North Slope. Across the ACP of the North Slope, breeding-season density averages approximately one pair per 8 km² for spectacled eiders (Larned, Stehn, and Platte, 2003). Steller's eiders are so rare in some years, that they are not detected at all by aerial-survey methods. In the core of the Steller's eider breeding area near Barrow, the highest nesting density recorded during 4 years of aerial surveys was estimated as approximately one pair per 12.5 km² (Ritchie and King, 2002). Densities elsewhere on the ACP are much lower.

There are a few notable differences in how birds could be affected in the Chukchi Sea that warrant special emphasis. The potential effects of aircraft disturbances could be similar to vessel-based disturbances (previous section) in terms of impacting ESA-protected birds in the Spring Lead System and the LBCHU.

Altitude restrictions have been used to separate birds and aircraft to reduce the potential to harm eiders (USDOI, MMS, 2006). Altitude restrictions often are impracticable in Arctic coastal areas, however, due to frequent inclement weather. Also, evidence suggests that some birds may habituate to certain sources of disturbance or avoid impacts associated with certain areas (USDOI, FWS, 2005). The use of designated flight paths could allow many birds, especially those in a specific area over several weeks or returning to a specific area year after year, to habituate to or use alternative areas to avoid aircraft impacts.

5.4.1.1.3 Collisions

Collisions could result from aircraft striking birds and birds striking vessels or offshore/onshore facilities. The potential could be elevated where birds concentrate such as in the spring lead system or the LBCHU.

Aircraft Striking Birds. Helicopter and fixed-wing aircraft operating at low altitudes have the potential to flush birds into the path of the aircraft, where a collision could occur. Approximately 90% of aircraft/bird collisions occur <1,500 ft above ground (Sodhi, 2002). Larned and Tiplady (1997) reported that flocks of wintering eiders often took flight during fixed-wing aircraft approaches of 150-200 m. While such strikes are relatively rare, aircraft/bird collisions could threaten the safety of aircraft and passengers and result in deaths of birds. Altitude restrictions have been used to separate birds and aircraft to reduce the potential harm to aircraft and birds (USDOI, MMS, 2006).

Birds Striking Vessels. Migrating birds colliding with vessels have been well documented. Weather conditions such as storms associated with rain, snow, icing, and fog or low clouds at the time of the occurrences often are attributed as causal factors (Weir, 1976; Brown, 1993). Lighting of structures, which can be intensified by fog or rain, also has been identified as a factor (Avery, Springer, and Dailey, 1980; Brown, 1993; Jehl, 1993). Birds are attracted to the lights, become disoriented, and may collide with the light-support structure (e.g., pole, tower, or vessel hull or superstructure).

Lights on fishing vessels at sea have been known to attract large numbers of seabirds during storms (Dick and Donaldson, 1978). Black (2005) reported a collision of about 900 birds, mostly a variety of petrel species and Antarctic prion, with a 75-m fishing trawler near South Georgia. The collisions took place over a 6-hour period at night, when visibility was <1 nautical mile (nmi), due to fog and rain. Of the 900 birds on deck, 215 were dead. Most of the remaining birds were released alive after being allowed to dry off in boxes stored in a protected area on deck. Waterfowl and shorebirds also have been documented as colliding with lighted structures and boats at sea (Schorger, 1952; Day, Prichard, and Rose, 2005). High-intensity lights are needed by vessels during some nighttime operations, or when visibility is hampered by rain or fog.

Marine birds risk collisions with vessels at night due to attraction and subsequent disorientation from high-intensity lights. Sea ducks are particularly vulnerable to collisions with vessels, primarily because they tend to fly low over the water. Johnson and Richardson (1982) documented that 88% of eiders migrating to molting areas along the Beaufort Sea coast flew below an estimated 10 m (32 ft), and over 50% flew below 5 m (16 ft). Eiders leaving the North Slope travel day or night. Movement rates (birds/hour) did not differ between night and day, but movement rates and velocities were higher on nights with good visibility (Day, Rose, Pritchard, et al., 2004).

Birds Striking Other Facilities. Birds can be killed by collisions with onshore and offshore structures (i.e., communication towers with support cables, overhead power lines, drilling structures, etc.). Eiders may be particularly vulnerable due to their flight behavior; they travel in relatively large flocks (~110 birds/flock), they fly fast (~83 km/hour), they fly low (5-12 m above sea level), and they tend to migrate in straight lines (~98% of observed flocks) (Day, Rose, Pritchard, et al., 2004; Day, Prichard, and Rose, 2005). A number of factors may reduce the height at which eiders migrate, including wind speed and direction, weather (i.e., fog or rain), and lighting (day vs. night) conditions (Day, Prichard, and Rose, 2005).

Day, Prichard, and Rose (2005) completed a 4-year study of bird migration and collision avoidance at Northstar Island. The authors used bird radar to assess the reaction of migrating eiders and other birds to collision-avoidance lights located on the production structure. The authors reported that the lights were not so strong that they disrupted eider migration, but the lights caused eiders to slow down and alter their flight paths away from the island.

Collision-related mortality to birds on the North Slope is difficult to estimate due to factors including:

- habitat effects, number of birds actually recovered likely vary relative to habitat;
- observer bias, different observers have different probabilities of actually recovering carcasses;
- scavenging bias, carcass longevity likely varies relative to local predator composition and abundance; and
- crippling bias, injured birds may walk or fly away from the collision site and die.

Thirty common eiders, 6 king eiders, and 13 long-tailed ducks were killed due to collisions with Northstar and Endicott islands in the Alaskan Beaufort Sea during fall migrations in 2001-2004 (Day, Prichard, and Rose, 2005). This total was collected over a relatively narrow window (80 days total spread over 4 years) of the fall migration and, thus, probably underestimates total collision loss during fall migration.

The greatest potential for collision impacts occurs where structures are within nearshore areas where birds, particularly eiders and long-tailed ducks, are known to migrate. Light radiated upward and outward from structures could disorient flocks of eiders and other birds during periods of darkness or inclement weather, when the moon is obscured. If migrating birds were not disoriented by radiated light, they still could encounter structures in their flight paths. Making surfaces visible to approaching birds may slow flight speed, allowing them to maneuver past collision hazards. Inward-directed lighting would illuminate these surfaces, but surface textures that absorb, rather than reflect, light could maximize visibility to closely approaching birds and minimize disorientation of distant birds during periods of darkness or inclement weather, when the moon is obscured.

5.4.1.1.4 Seismic-Airgun Noise

Oil and gas prospects need to be identified and delineated before they can be developed. This assessment is conducted by interpreting seismic data and by drilling. Because seismic surveys conducted on land are completed during winter months, direct effects to birds are few. For purposes of analysis, BOEMRE assesses the potential effects of vessel-based seismic surveys in marine areas of the Chukchi and Beaufort seas. The primary effects could arise from airgun noise.

Seismic surveying with airgun arrays results in both vertical and horizontal sound propagation. Horizontal propagation is a relevant issue, because it is less likely that marine birds would be under the array. Although there is variation in attenuation rates depending on bottom slope and composition, sound from airgun arrays can be detected using hydrophones at ranges of 50-75 km in water 25-50 m deep (Malme, 1995).

Few studies have assessed the effects of seismic surveys on marine birds and waterfowl. Stemp (1985) observed responses of northern fulmars, black-legged kittiwakes, and thick-billed murres to seismic activities in Davis Strait offshore of Baffin Island. The first 2 years of the study involved the use of explosives (dynamite gel or slurry explosives) and, therefore, are not relevant, as use of underwater explosives are not being used for seismic surveys in the lease-sale area. The final year of the study involved airguns, but the study locations were never in sight of colonies, feeding concentrations, or flightless murres. The results of this study did not indicate that seabirds were disturbed by seismic surveys using airguns. This conclusion, however, was due in part to natural variation in abundance. Nevertheless, Stemp (1985) concluded that negative effects from seismic surveys were not anticipated as long as activities were conducted away from colonies, feeding concentrations, and flightless murres. This implies, however, that conducting these activities near colonies, feeding concentrations, or molting birds could result in negative effects to birds.

Lacroix, Lanctot, Reed, et al. (2003) investigated the effects of seismic surveys on molting long-tailed ducks in the Beaufort Sea. These ducks molt in and near coastal lagoons on the North Slope, primarily during August, during which time they are flightless for 3-4 weeks. The molt is an energetically costly period. Long-tailed ducks are small sea ducks with higher metabolic rates and lower capacity to store energy than larger ducks (Goudie and Ankney, 1986). Consequently long-tailed ducks need to actively feed during the molt period because their energy reserves cannot sustain them during this period (Flint, Reed, Franson et al., 2003). Lacroix, Lanctot, Reed, et al. (2003) stated there was no clear response by the ducks to seismic surveying, even when the seismic vessels were in visual range. However, there may be effects that were too subtle to be detected by this study. The presence of long-tailed ducks within 2.5-km radii of the sound source was monitored, but it was not possible to determine short-distance movements in response to seismic activities. Diving behavior of long-tailed ducks also was monitored by radio-telemetry, because direct observations may have induced bias due to the presence of observers. Therefore, it is unclear whether changes in diving frequency were due to disturbance from seismic vessels or local abundance of prey items. For instance, ducks may dive more in response to disturbances from vessels or they may dive less to avoid underwater noises related to airguns. Although the Lacroix, Lanctot, Reed, et al. (2003) study found no effect of seismic surveying on movements or diving behavior of long-tailed ducks, additional behavioral observations are necessary to further document the response of long-tailed ducks and other birds to seismic surveys.

While seismic airguns have the potential to alter the availability of marine bird prey, Vella, Rushforth, Mason et al. (2001) concluded that there generally are few behavioral or physiological effects unless the organisms are very close (within meters) to a powerful noise source. Consequently, noises from seismic airguns are not likely to decrease the availability invertebrate crustaceans, bivalves, or mollusks.

While it is possible that seismic surveys might affect fish and invertebrates in proximity to the airgun array, there have been no documented effects of seismic surveys on marine fish that change their availability to marine birds under field operating conditions (Canadian Department of Fisheries and Oceans [CDFO] 2004). However, if forage fishes are displaced by airgun noise, birds feeding on those resources might be temporarily displaced and stop feeding near the survey activities.

It is possible, during the course of normal feeding or escape behavior that some birds could be near enough to an airgun to be injured by a pulse. The threshold for physiological damage, namely to the auditory system, for marine birds is unknown. Although BOEMRE has no information about the

circumstances where this might occur, the reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all. “Ramping-up,” a gradual increase in decibel level as the seismic activities begin, can allow diving birds to hear the start up of the seismic survey and help disperse them before harm occurs. During seismic surveys, diving birds likely would hear the advance of the slow-moving survey vessel and associated airgun operations and move away.

5.4.1.1.5 Discharges

Discharges include those materials authorized for release into surrounding waters under specific permits and oil spills, which are accidental or unauthorized releases of oil into the marine environment.

Authorized Discharges

A general NPDES permit from the EPA will be required to authorize discharges from oil and gas exploration facilities. The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

Oil Spills

Potential exposure of birds to petroleum could result from a number of ongoing or future oil and gas activities on the Alaskan Arctic OCS. Other sources of petroleum spills include vessel sinkings or accidents and equipment malfunctions during bulk fuel transfers. Spilled fuel/oil in the Chukchi Sea or Beaufort Sea would be a serious threat to birds because it forms a thin liquid layer on the water surface. The spring lead system and the LBCHU are important areas where large numbers of ESA-protected species could be affected.

Bird deaths due to oil spills arise from exposure from wetting and loss of thermoregulatory ability, loss of buoyancy, or from matted plumage and inability to fly or forage (Fry and Lowenstine, 1985). Alcids and sea ducks are highly vulnerable to oil spills, because they spend most of their time on the sea surface and aggregate in dense flocks. In the event of a spill, birds could die due to the following direct and indirect effects:

Covering of Skin or Feathers. Fouled plumage is the primary cause of mortality and stress in oiled birds (Burger and Fry, 1993). The hydrophobic nature of petroleum hydrocarbons makes them interactive with the hydrophobic properties of bird feathers. Oil causes marked loss of insulation, waterproofing, and buoyancy in the plumage. Oiled feathers lose their ability to keep body heat in and cold water out, and resultant hypothermia can kill birds. Waterlogging and loss of buoyancy can rapidly lead to drowning.

Inhaling Hydrocarbon Vapors. Birds have the most efficient respiratory system of all vertebrates (Welty, 1975) and could be more susceptible to harm from inhaling hydrocarbon vapors than mammals. The following conclusions are based on Geraci and St. Aubin (1982) as applied to birds. Inhaled petroleum vapors are absorbed into the bloodstream and carried throughout the body. Inhalation of highly concentrated petroleum vapors can lead to inflammation and damage of the mucous membranes of the airways, lung congestion, emphysema, pneumonia, hemorrhage, and death. It is unlikely that vapor concentrations can reach critical levels for more than a few hours. If a bird were unable to leave the immediate area of the source of the spill or were confined to a contaminated lead or bay, it could inhale enough vapors to cause some damage. Birds away from the immediate spill area or exposed to weathered or residual oils would not be expected to suffer any adverse effects from vapor inhalation.

Ingesting Oil or Contaminated Prey. Petroleum oils contain many toxic compounds that can have fatal or debilitating effects on birds when ingested (Burger and Fry, 1993). Both crude and bunker

oils produced intestinal irritation in birds. Oils with high polyaromatic hydrocarbon contents are known to cause precipitation of hemoglobin leading to anemia. In experiments with two species of marine birds, Leighton, Peakall, and Butler (1983) found that severe hemolytic anemias occurred from ingestion of large amounts of crude oil. The major route by which birds would be expected to ingest oils is by preening it off their feathers after exposure. These same toxic compounds could be absorbed through the skin.

There are numerous other routes of injury to birds from ingested oil (Burger and Fry, 1993). The osmotic regulation of blood and tissue fluids is influenced by several organs, including intestines, kidneys, and salt glands, which might be susceptible to oil toxicity. Osmotic stress can be fatal, or can exacerbate the effects of shock and cold stress in oiled birds. Significant changes in the size of the adrenal glands and levels of corticosteroids have been found in several studies where small amounts of oil were fed to birds. Liver and kidney damage was reported as direct effects of crude and fuel oil ingestion in several studies on birds. Ingestion of oils can reduce the functions of the immune system and reduce resistance to infectious diseases. Additionally, food may be contaminated either directly or by hydrocarbons within the food chain.

Reproductive Effects. Ingested oil causes short- and long-term reproductive failure in birds, indicative of severe physiological problems. These include delayed maturation of ovaries, altered hormone levels, thinning of eggshells, reduced egg productivity, reduced survival of embryos and chicks, reduced chick growth, and abandonment of nests by adults (Burger and Fry, 1993). Cassin's auklets experienced reduced reproduction after exposure to Prudhoe Bay crude oil (Ainley, Grau, Roudybush et al., 1981). It is unknown if exposed adults could become permanently sterilized.

If adults engaged in a futile attempt to hatch a dead embryo, their reproductive effort for that year would be lost. Even if they were to attempt to re-nest later in the season, it is doubtful that their late-hatching young would survive. Some species, such as Kittlitz's murrelets, typically raise only one chick per year.

Both parents of some species incubate eggs and bring fish for their young. Lightly oiled birds could bring oil contamination back to their nest where eggs and young could be contaminated. Lightly oiled birds also could bring contaminated food to the nest. Heavily oiled birds would be prevented from returning to the nest resulting in the young dying of starvation.

Reduced Food Sources. Food resources used by birds could be displaced from important habitats or be reduced following a petroleum spill. Benthic habitats that support marine invertebrates, however, would not be expected to experience substantial adverse effects following a spill.

Displacement from Feeding or Molting Areas. The presence of substantial numbers of workers, boats, and aircraft activity between the spill site and support facilities is likely to displace birds foraging in affected offshore or nearshore habitats during open-water periods for one to several seasons. Disturbance during the initial response season, possibly lasting as long as 6 months, is likely to be frequent. Cleanup in coastal areas late in the breeding season may disturb brood-rearing, juvenile, or staging birds.

Activities such as hazing and other human activities (boat and air traffic) could disturb birds in the nearshore environment. Hazing may have limited success during spring, when migrants occupy open-water ice leads. The hazing effect of cleanup activity or actively hazing birds out of ice leads that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy. Cleanup activities in leads during May and open water in July through September are likely to adversely affect marine and coastal birds, including birds in coastal areas.

Oil-spill response could originate from as far away as Deadhorse, about 150 mi east of Barrow. Specific animal-deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with FWS and State officials on wildlife management activities in the event of a spill. In an actual

spill, the two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed hazing activities and monitor their impact on birds. As a member of the team, FWS personnel would be largely responsible for providing critical information affecting response activities to protect migratory birds in the event of a spill.

Small Spills. Beached-bird surveys have demonstrated that low-volume chronic oil pollution is an ongoing source of mortality in coastal regions (Burger and Fry, 1993). Small volumes of oil may be released from leaking tanks and valves, accidents during loading and offloading, and flushing of tanks and bilges. In cold climates, an oil spot the size of a square inch is enough to compromise water repellency of plumage, possibly leading to the death of a bird. In some places, such as the Atlantic coast of Canada, low-volume, chronic oiling is a major cause of seabird mortality (Wiese and Ryan, 2003; Wells, 2001; Wiese and Robertson, 2004).

Summary of Potential Spill Effects. Direct oil/fuel contamination of birds likely would result in loss of feather insulation and acute and chronic toxicity from ingestion and absorption. Oiled birds also could carry oil to nests where eggs and young could be oiled. The combined effects of oiled plumage, osmotic and thermal stress, and anemia greatly could increase the mortality of birds under adverse environmental conditions. Spilled oil can originate from a variety of sources and be in the form of a large spill, small spill or chronic small spills. Research indicates that while larger spills have more immediate mortality, the combined mortality from chronic smaller spills could surpass the effects from a large spill.

5.4.1.2 Anticipated Effects from Exploration

Effects Definitions and Levels. BOEMRE used the terms negligible, minor, moderate, and major to describe the relative degree or anticipated level of effect of an action on birds and polar bears. Following each term below are the general characteristics BOEMRE used to determine the anticipated level of effect. For all terms, best professional judgment was used to estimate population size when current or precise numbers were not known.

Threatened and Endangered Birds

- **Negligible:** Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across 1 year. No mortality is anticipated. Mitigation measures implemented fully and effectively or not necessary.
- **Minor:** Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across one year or localized effects that are anticipated to persist for more than 1 year. Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local post-breeding population. Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable. Unmitigable or unavoidable adverse effects are short-term and localized.
- **Moderate:** Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than 1 year, but less than a decade. Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local post-breeding population, which may produce a short-term population-level effect. Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities would likely be effective in reducing the level of avoidable adverse effects. Unmitigable or unavoidable adverse effects are short-term but more widespread.
- **Major:** Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer. Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local post-breeding population, which could produce a long-term population-level effect. Mitigation measures are implemented for limited activities, but more

widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects. Unmitigable or unavoidable adverse effects are widespread and long-lasting.

5.4.1.2.1 Vessel Traffic

Oil and gas exploration activities in the Beaufort Sea OCS are anticipated to result in limited disturbance potential experienced by Steller's and spectacled eiders. The Proposed Action could result in a continuation of existing levels of seismic-vessel activity in the Chukchi Sea. The incremental increase in the total number of vessels operating under BOEMRE-authorized actions described by the Proposed Action would have proportionately fewer impacts compared to other unrestricted vessels operating in this area. Mitigation measures imposed by BOEMRE on existing and future exploration and development activities avoid or minimize adverse effects to ESA-listed birds in the Arctic Region OCS.

5.4.1.2.2 Aircraft Traffic

The Proposed Action could result in a continuation or limited expansion of existing levels of exploration activity in the Alaskan Arctic OCS (compared to 2006, 2007, and 2008). Low-level aircraft traffic could adversely affect listed birds by: (1) displacing adults and/or broods from preferred habitats during pre-nesting, nesting, and brood-rearing and migration; (2) displacing females from nests, exposing eggs or small young to inclement weather or predators; and (3) reducing foraging efficiency and feeding time. The behavioral response of eiders to low-level aircraft flights is unknown; some spectacled eiders nest and rear broods near the Deadhorse airport, indicating that some individuals tolerate frequent aircraft noise. Individual tolerances are expected to vary, however, and the intensity of disturbance, in most cases, would be less than that experienced by birds at the Deadhorse airport.

Disturbance to nesting spectacled and Steller's eiders from the Proposed Action would be limited by their extremely low densities across the North Slope. Across the ACP of the North Slope, breeding season density averages approximately one pair per 8 km² for spectacled eiders (Larned, Stehn, and Platte, 2003). Steller's eiders are so rare in some years that they are not detected at all by aerial-survey methods. In the core of the Steller's eider breeding area near Barrow, the highest nesting density recorded during four years of aerial surveys was estimated as approximately one pair per 12.5 km² (Ritchie and King, 2002). Densities elsewhere on the ACP are much lower.

The number of nesting Steller's or spectacled eiders that would be exposed to low-level flights associated with OCS oil and gas exploration is low, because the potential direct flight from an air base to offshore work sites within the Alaskan Arctic OCS would be primarily over coastal waters. Mitigation measures imposed on existing and future exploration activities avoid or minimize adverse effects to ESA-listed birds rearing or staging in the Beaufort and Chukchi seas. Aircraft activities under the Proposed Action are anticipated to result in a negligible level of effect on ESA-protected birds.

5.4.1.2.3 Collisions

Mitigation measures imposed on exploration activities are believed to minimize collision mortality to ESA-listed birds in the Alaskan Arctic OCS. At this time, however, BOEMRE cannot assume that recommendations for the design and implementation of lighting of structures would result in no strikes by threatened eiders. BOEMRE and FWS both acknowledge that estimating incidental take of listed eiders is extremely difficult. There were a variety of assumptions made to support these calculations and BOEMRE has maintained the use of the same variables in estimated incidental take calculations for purposes of comparison.

Exploration activities under the Proposed Action could increase the total number of structures, particularly vessels, in the project area. Mitigation measures imposed on exploration activities are

believed to minimize collision mortality to ESA-listed birds in the Chukchi Sea. Vessels and drillships, for example, must operate their lights to minimize collisions. An estimated incidental take of listed species was calculated in the BO for the Beaufort Sea Lease Sale 186 (USDOI, MMS, 2003). Collisions with preproduction structures on existing leases in the Beaufort Sea OCS were calculated to result in an incidental take of five spectacled eiders and one Steller's eider (USDOI, MMS, 2003).

An estimated incidental take of listed species was calculated in the Biological Opinion for the Chukchi Sea Lease Sale 193 (USDOI, FWS, 2007). Collisions with exploration structures on existing leases in the Chukchi Sea OCS were calculated to result in an incidental take of three spectacled eiders and one Steller's eider. BOEMRE considers this number to accurately reflect estimated incidental take under the Proposed Action. BOEMRE considers incidental take from the Proposed Action to be an unavoidable, but minor level of effect to listed eiders. A negligible level of effect on Kittlitz's murrelets and yellow-billed loons is anticipated. No population-level of effect to ESA-listed birds is anticipated.

5.4.1.2.4 Seismic Airgun Noise

Seismic surveys are used to locate and delineate potential oil and gas prospects. Most seismic activity on land or ice is done during winter, when ESA-protected birds are absent.

Seismic surveys and related support activities in the OCS are typically conducted from vessels during the ice-free, open-water period. The Proposed Action includes seismic survey/exploration/delineation activities on existing and future OCS leases and it is reasonable to expect leaseholders and others to investigate the potential for oil or gas production in the future. While there likely would be a continuation of seismic activity in the Chukchi Sea, BOEMRE will impose mitigation measures on future seismic survey activities to avoid or minimize adverse effects to ESA-listed birds in the Arctic Region OCS. A negligible level of effect from these activities is anticipated.

Conclusion. Seismic activity under the Proposed Action is anticipated to result in a negligible effect on threatened and endangered birds in the Alaskan Arctic.

5.4.1.2.5 Discharges

Discharges include those materials authorized for release into surrounding waters under specific permits and oil spills, which are accidental or unauthorized releases of oil into the marine environment.

Authorized Discharges

Discharges from the Proposed Action would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or through affecting prey species. Adverse effects to benthic invertebrates that could be important to listed birds would be negligible when compared to their availability in the surrounding areas. Any effects would be localized primarily around the drill rig because of the rapid dilution or deposition of these materials. Because the discharges would be regulated through Section 402 of the CWA, typical discharge criteria and other mitigation measures, authorized discharges are expected to have a negligible level of effect on listed birds in the Arctic Region OCS.

Oil Spills

Oil spills are accidental or unlawful events that are evaluated according to three different size categories: small, large, and very large (see Appendix A).

Small Oil Spills

Small oil spills are defined as <1,000 bbl. The average crude-oil spill size is 3 bbl for spills <500 bbl. Small spills could occur during G&G activities or exploration drilling activities. Small fuel spills associated with the vessels used for G&G activities could occur, especially during fuel transfer. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1-13 bbl. The <1 bbl volume considers dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers spill prevention measures fail or fuel lines rupture. There are no reported historical fuel spills from geological or geophysical operations on the Chukchi and Beaufort OCS.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum anticipated annual levels of geophysical or geological activities could range from 0 if no fuel spills occur to <9 barrels if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations for Beaufort Sea operations likely would occur at Prudhoe Bay's West Dock facility, in Tuktoyuktok, Canada, or at sea with the use of fuel supply vessels. Refueling operations in the Chukchi Sea likely would occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. A ≤50 bbl spill was estimated to occur during exploration drilling operations from refueling (Appendix A).

Some small spills could be in or close to areas used by listed birds. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from listed birds and reduce the opportunity for them to contact these spills. A negligible level of effect on listed birds is anticipated from small oil spills.

Large Oil Spill

No large oil spills are estimated from exploration activities (see Appendix A). A large spill scenario is evaluated under the development and production phase (Section 5.4.2.2.8). While not a part of the Proposed Action, the described effects of this low-probability event are indicative of the level of effect such an event could have in the Arctic Region OCS during exploration. That analysis reflects the degree to which a large oil spill could affect listed birds in the Arctic Region OCS, regardless of phase (exploration vs. development and production) because the effects to the resources are based on oil in the environment, not on whether it originated from exploration or development or production.

5.4.2 Direct and Indirect Effects of Development and Production

The principal sources of adverse effects to ESA-protected birds in the Beaufort and Chukchi seas during development and production include:

- vessel traffic
- aircraft traffic
- collisions
- discharges
- increased bird predator populations
- increased subsistence-hunting activity and
- habitat loss

In this section BOEMRE describes potential effects and then evaluates the anticipated effects (Section 5.4.2.2) of the Proposed Action including mitigation measures.

5.4.2.1 Background of Effects

The background of effects of vessel traffic, aircraft traffic, collisions, discharges, and seismic airgun noise were described in Section 5.4.1.2. Additional background effects requiring further consideration

during development and production from increased predator populations, subsistence activity, and habitat loss include:

5.4.2.1.1 Increased Bird Predator Populations

Predation is believed to be a principal cause for nesting failure. Predators of listed birds along the Chukchi and Beaufort seas include snowy owls, peregrine falcons, gyrfalcon, pomarine and long-tailed jaegers, rough-legged hawks, common ravens, glaucous gulls, and Arctic and red foxes. Primary predators are foxes, gulls, and ravens. The current distribution and abundance of these predators have received some research attention, but ravens, for example, have existed commensally with small communities or structures across the North Slope for decades (see Day, 1998). Other species, especially raptors, are young, dispersing birds transiting the area after the breeding season.

Several of these bird predators that prey on waterfowl eggs and young concentrate in areas where human-use foods and garbage are available. Examples include gulls, ravens, and Arctic foxes that are abundant near camps, roads, oilfields and villages. For ravens and foxes, there is evidence indicating population increases and range expansion due to increased availability of nesting or denning sites on these developments where they did not previously exist.

The predation pressure that foxes, gulls, and ravens exert on nesting birds, especially waterfowl, is well documented and, in some areas, predation is the predominant factor affecting nest success. The greatest direct impact on marine and coastal bird populations would occur when predator densities are high and densities of nesting birds are low. Excessive predation on nesting females also can result in imbalanced sex ratios within populations. Increased predation poses a potentially major adverse impact to bird populations on the North Slope.

5.4.2.1.2 Increased Subsistence-Hunting Activity

Alaskan Natives traditionally have harvested a wide variety of birds on the North Slope. While this harvest continues under State and Federal regulations, some species cannot be harvested because their populations have declined to low levels. Subsistence-harvest surveys for the North Slope indicate that an average of 155 spectacled eiders were taken at Wainwright during 1988-1989, and only 2 spectacled eiders were reported taken in Barrow during 1987-1990 (S.R. Braund and Assocs., 1993a, b). Some accidental harvest of protected species is believed to occur through misidentification.

5.4.2.1.3 Habitat Loss from Facility Construction and Operation

Habitat loss occurs as facilities are developed, covering tundra habitats used by birds for nesting, foraging, brood-rearing, and molting. Hundreds of acres of North Slope bird habitats have been filled by oil and gas infrastructure (fill pads, pipelines, roads, gravel pits, etc.), as well as community development (residences, schools, airports, roads, landfills, etc.). Secondary impacts occur from altered hydrology associated with these facilities, flooding areas and drying others. While some species may have or will benefit from wetter or drier habitats near these facilities, evidence suggests that many birds avoid using habitats near these developments and the human activities they support. For example, regular vehicle traffic on roads could result in the permanent displacement of nesting birds in a zone of influence around developments.

Habitat loss could be more important in the Chukchi Sea due to the designation of some offshore areas as critical habitat under the ESA.

5.4.2.2 Anticipated Effects from Development and Production

Development and production are not reasonably certain to occur, and if proposed, would require consultation under the ESA. Should development and production be proposed, the activities that could affect listed birds include vessel and aircraft traffic, collisions, seismic airgun noise, increased bird predator populations, increased hunting mortality, facility construction and operation, and discharges.

5.4.2.2.1 Vessel Traffic

Vessel-related activities associated with development and production (on the OCS) are anticipated to result in limited potential disturbance to Steller's and spectacled eiders. The Proposed Action could result in a continuation or limited expansion of existing levels of seismic-vessel activity in the Chukchi Sea. The incremental increase in the total number of vessels operating under BOEMRE-authorized actions described by the Proposed Action would have proportionately fewer impacts compared to other unrestricted vessels operating in this area. Mitigation measures imposed by BOEMRE on existing and future exploration and development activities avoid or minimize adverse effects to ESA-listed birds in the Alaskan Arctic OCS. Vessel activities under the Proposed Action are anticipated to result in a negligible level of effect on ESA-protected birds.

5.4.2.2.2 Aircraft Traffic

Aircraft traffic effects are essentially the same during Exploration. Refer to section 5.4.1.2.2 for more detail on the effects of aircraft on marine and coastal birds.

5.4.2.2.3 Collisions

Although development and production from existing and future Beaufort Sea leases is not reasonably certain, as many as 21 spectacled eiders (calculated as $= 0.40$ (spectacled eider strike rate) \times 26 years (life of production) \times 2 (maximum number of platforms)) and one Steller's eider (calculated as $= 0.02$ (Steller's eider strike rate) \times 26 years (life of production) \times 2 (maximum number of platforms)) were calculated to occur from collisions with structures associated with production drilling on existing leases in the Beaufort Sea OCS. Further Section 7 consultation with FWS under the ESA would be required for any proposed development of Beaufort Sea OCS leases. BOEMRE would not authorize any development proposal that was determined to be likely to jeopardize the continued existence of an ESA-listed species.

Similarly, development and production from existing or future Chukchi Sea leases is speculative, and BOEMRE calculated that mortality of as many as 17 spectacled eiders and one Steller's eider could occur from collisions with structures associated with hypothetical production drilling in the Chukchi Sea OCS. As the scenario remains unchanged, this number also would represent the hypothetical developmental collision impacts from the Proposed Action.

The one aspect of the natural gas production scenario with the potential to affect Threatened and Endangered birds is the risk of collisions with vessels and infrastructure. The FWS 2007 BO concludes that approximately 3 adult spectacled eiders and 1 adult Steller's eider could be killed per year through collision with vessels and structures associated with the oil development and production scenario outlined in the Sale 193 FEIS. The similarities between the oil development and production scenario analyzed in the Sale 193 FEIS and the natural gas development and production scenario analyzed here suggest that FWS' estimated collision rate could be useful to the current discussion. If crude strike rates were applied to the production platform (0.4 strikes/year for spectacled eiders and 0.02 strikes/year for Steller's eiders), an estimated 8 spectacled eiders and 1 Steller's eider (0.4 rounded up) could be lost through collisions with a structure located offshore over the entire 20 years of gas production.

5.4.2.2.4 Seismic Airgun Noise

Seismic Airgun Noise is generally limited to the Exploration phase, and is not considered to be applicable to the Development and Production phases.

5.4.2.2.5 Increased Bird Predator Populations

Increased predator populations would only arise from the construction of development and production facilities, which are not considered reasonably certain. If development and production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects

to ESA-listed birds in the Beaufort and Chukchi seas. While there likely would be an incremental increase in the total number of structures or facilities that could be used by bird predators, such as ravens or foxes, these facilities would not be constructed or operated in a manner that would support bird predators. For example, a lease stipulation (requiring that new infrastructure would avoid the artificial enhancement of predator populations) recently has been implemented for the Liberty project. Implementation and enforcement of a leasing stipulation could be expected to minimize any effects of increased predator populations resulting from BOEMRE actions in the Arctic Region OCS. The Proposed Action is anticipated to result in a negligible effect from increased bird predator populations in the Alaskan Arctic.

The operation of a gas production facility and pipeline would not change the distribution or abundance of bird predators as no new sources of nesting/denning sites or access to artificial food sources would be generated. Resident fox populations would continue to be affected by winter food supply and disease.

5.4.2.2.6 Increased Subsistence-Hunting Activity

Increased subsistence-hunting activity could arise from the construction of development and production facilities, which are not considered reasonably certain to occur. If development and production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to ESA-listed birds in the Alaskan Arctic associated with oil and gas development from the Alaskan Arctic OCS.

There likely would be an incremental increase in the total number of gravel roads that could be used by bird hunters. For example, BOEMRE assumes that a pipeline would carry products to pre-existing infrastructure for transport to processing facilities. The pipeline(s) would need a road for periodic maintenance and this road could increase access of local hunters to previously inaccessible areas. Waterfowl hunters may be able to access pipeline roads during the period immediately following spring breakup to hunt geese and eiders, but it is unknown whether increased access would result in an increased harvest of spectacled or Steller's eiders. The long-term consequences of development and production would be evaluated via formal consultation under the ESA but, at the present time, changes in subsistence hunting under the Proposed Action are anticipated to result in negligible effects on ESA-listed birds. No changes in subsistence hunting are anticipated under the Proposed Action and negligible level of effect on ESA-listed birds is anticipated.

5.4.2.2.7 Facility Construction and Operation

Temporary habitat loss may arise during the construction of development and production facilities (offshore platform(s), undersea pipeline(s), pipeline landfall(s) to an onshore base, and pipeline(s) linking to existing infrastructure), which, however, are not considered reasonably certain to occur. If production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to ESA-listed birds in the Alaskan Arctic. While there likely would be an incremental increase in the total number of acres of eider habitat eliminated, nesting habitat has not been identified as a factor limiting eider populations. Indirect habitat losses could result from eiders, yellow-billed loons, and murrelets not using habitats near sites of industrial activity.

Facility Construction and Operation Associated with Beaufort Sea Development and Production

Direct impacts to spectacled and Steller's eider nesting habitats arise from the facility footprint. BOEMRE can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production, but these were estimated for the Beaufort Sea (Table 4.4.2.6.2-1, USDOJ, MMS, 2008). Onshore developments would originate at a pipeline landfall, the location of which has not been determined. The pipeline and associated developments conceivably would then be the shortest, most cost-effective route to connect with pre-existing support infrastructure.

- Two options for pipeline installation are either on elevated structures or, less frequently, buried within a 0.03 km-wide (100 ft-wide) road/pipeline corridor. Assuming the corridor to be 80 km (50 mi) long, direct impacts from pipeline and road construction are estimated to affect 2.45 km² (606 acres) of eider nesting habitat (Table 4.4.1.6.2-1).
- The shore base and staging facilities are assumed to each have gravel footprint of 0.2 km² (50 acres) on eider nesting habitat. As many as two pump stations would be needed to move oil, and these stations are estimated to each have a gravel footprint of 0.16 km² (40 acres). Additional airstrip construction or use of overland ice roads/pads is not anticipated.
- Material to construct the road, shore base, and other facilities would likely come from upland gravel pits, if practicable, or from coastal areas (intertidal areas, barrier islands, etc.) if no feasible and prudent non-coastal alternative is available. The locations of gravel sources near a future alignment are unknown; however, there is some potential that some known gravel sources (identified in USDO, BLM and MMS, 2003, presently undeveloped) or existing gravel pits would be used or expanded for material-construct fill for the development facilities. For purposes of analysis, an estimated 0.40 km² of eider nesting habitat would be affected by gravel extraction. Overall, these developments are estimated to have a footprint of 3.41 km² (845 acres) in eider nesting habitats, resulting in an estimated take of four spectacled eiders and one Steller's eider (Table 4.4.1.6.2-1, USDO, MMS, 2008). No critical habitat for ESA-protected birds has been designated in the Beaufort Sea.

Temporary and indirect habitat loss via displacement during construction and operation could occur if production facilities (offshore platform, undersea pipeline) are located in areas used by Steller's and spectacled eiders and the candidate species. Indirect habitat losses could result from eiders, murrelets, and loons not using habitats near sites of industrial activity. An offshore production platform could have multi-decadal displacement effects on eiders and other birds using this area.

Secondary or indirect effects to nesting eiders would arise from terrestrial habitat modifications (drainage, flooding, dust impacts to vegetation, changes in thermokarst) and disturbances from traffic and human activities. The rationale for these calculations and the biological basis for a "zone of influence" are detailed in BLM biological assessment (USDO, BLM, 2003) and FWS biological opinion (USDO, FWS, 2005) and are not repeated here. As with previous calculations, our calculations used a zone of influence away from developments measuring 200 m (656 ft). Our calculations did not take into account the amount of overlap in the secondary effects zone that would occur where certain facilities meet. Overall, these zones of influence associated with development facilities have a collective areal extent of 33 km² (8,327 acres) in eider nesting habitats, resulting in an estimated indirect take of 36 spectacled eiders and two Steller's eiders (Table 4.4.1.6.2-1, USDO, MMS, 2008).

Spectacled and Steller's eiders are not present during the winter; therefore winter activities would have less impact on them. The scenario assumes that material extraction takes place during the winter to take advantage of the eider's absence.

Overall, developments in the Beaufort Sea are estimated to have a direct footprint of 3.41 km² (845 acres) in eider nesting habitats, resulting in an estimated take of four spectacled eiders and one Steller's eider. Overall, these zones of influence associated with development facilities have an estimated collective areal extent of 33 km² (8,327 acres) in eider nesting habitats, resulting in an estimated indirect take of 36 spectacled eiders and two Steller's eiders (Table 4.4.2.6.2-1, USDO, MMS, 2008).

These projects would require Section 7 consultation. As with the Lease Sale 193 Final EIS (see Information to Lessees, Section 4.5.1.6.2.3.2.4, USDO, MMS, 2008), under the Proposed Action BOEMRE would/could not authorize a future project if it were likely to jeopardize the continued existence of Steller's or spectacled eiders or result in adverse modification of designated critical

habitat as determined by FWS. BOEMRE believes that this condition will help industry incorporate stringent measures into their plans that avoid the risk of population-level effects on ESA-protected species in the Beaufort Sea.

Facility Construction and Operation Associated with Chukchi Sea Development and Production

BOEMRE can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production in the Chukchi Sea, but it was estimated in the Sale 193 final EIS (USDOI, MMS, 2007) and remains essentially the same for the Proposed Action (Table 4.5.1.6.2-1, USDOI, MMS, 2008):

- Two options for pipeline installation are either on elevated structures or, less frequently, buried within a 0.03 km-wide (100-ft-wide) road/pipeline corridor. Assuming the corridor to be 482.8 km (300 mi) long, direct impacts from pipeline and road construction are estimated to affect 14.72 km² (3,636 acres) of eider nesting habitat.
- The shore base and staging facilities were assumed to each have gravel footprints of 0.2 km² (50 acres) on eider nesting habitat. Up to four pump stations would be needed to move oil eastward and these stations are estimated to each have a gravel footprint of 0.16 km² (395 acres total).
- Material to construct the road, shore base, and other facilities would likely come from upland gravel pits, if practicable, or from coastal areas (intertidal areas, barrier islands, etc.) if no feasible and prudent non-coastal alternative is available. The locations of gravel sources near a future alignment are unknown, however it is likely that some known gravel sources (identified in NPR-A, presently undeveloped) or existing gravel pits would be utilized/expanded for material construct fill for the development facilities. For the purposes of analysis, BOEMRE estimated that 1.60 km² of eider nesting habitat would be affected by gravel extraction.

Overall, these developments have a footprint of 17.37 km² (4,291 acres) in eider nesting habitats, resulting in an estimated direct take of 19 spectacled eiders and one Steller's eider.

Overall, these zones of influence associated with development facilities developments have a collective areal extent of 196.13 km² (48,464 acres) in eider nesting habitats, resulting in an estimated direct take of 216 spectacled eiders and 12 Steller's eider.

After oil production, facilities may be converted to gas production. This would occur several decades after oil production began and is much more speculative. A pipeline for gas delivery is expected to be placed along a future oil pipeline, with approximately another 10 m wide fill footprint (USDOI, BOEMRE, 2011). Additional facility footprints in listed eider habitats were not considered necessary. The road/pipeline corridor was assumed to be 482.8 km (300 miles) long. Consequently, indirect nesting habitat impacts from a gas pipeline construction are estimated to affect 4.83 km² (1,193.8 acres). Consistent with previous calculations which used nesting densities of 1.1 nests/km² for spectacled eiders and 0.06 nests/km² for Steller's eider, an estimated take of 5.3 spectacled eiders and <1 Steller's eider could occur during construction of a gas pipeline.

Temporary and indirect habitat loss via displacement during facility construction and operation could occur if production facilities (offshore platform, undersea pipeline) are located in areas used by Steller's and spectacled eiders and the candidate species. Indirect habitat losses could result from eiders, murrelets, and loons not using habitats near sites of industrial activity. Drilling offshore exploration wells would result in a temporary loss (via displacement) of spectacled eider habitat. There will be no production platforms with the Ledyard Bay Critical Habitat Unit, because no leases occur there.

Other secondary or indirect effects to nesting eiders would arise from terrestrial habitat modifications (drainage, flooding, dust impacts to vegetation, changes in thermokarst) and disturbances from traffic and human activities. For the purposes of consistency in estimating the incidental take of spectacled and Steller's eiders associated with indirect loss of nesting habitat, MMS/BOEMRE decided to adopt the methodology used by recent similar projects for NPR-A (USDOI, BLM, 2003; USDOI, FWS, 2005). The rationale for these calculations and the biological basis for a "zone of influence" are detailed in those biological assessments and resultant biological opinions and are not repeated here. As with previous calculations, our calculations used a zone of influence away from developments measuring 200 m (656 ft). Our calculations did not take into account the amount of overlap in the secondary effects zone that would occur where certain facilities meet (Table 4.5.1.6.2-1, USDOI, MMS, 2008).

Spectacled and Steller's eiders are not present during the winter; therefore winter activities would have less impact on them. The scenario assumes that material extraction takes place during the winter to take advantage of the eider's absence.

Operation of a gas production facility includes the unlikely effects from flaring, including a loss of control. As with the small amounts of natural gas periodically flared during oil production operations, the release and flaring of 10 million ft³ of natural gas during a one day loss of gas well control would affect few birds in the immediate vicinity. Some migrating birds may become disoriented by the flare, especially during periods of darkness or inclement weather and could increase their potential for colliding with the platform structure. As collisions with structures in the Chukchi and Beaufort seas are typically low, the effects on non-listed bird species would be minimal; however, any collision mortality of spectacled or Steller's eiders would be considered a significant adverse effect if these bird losses were not recovered within a generation. No adverse effects on coastal and marine birds are anticipated from a sudden release of natural gas from a pipeline rupture because the gas would typically dissipate into the atmosphere instead of lingering in a localized area where birds could be present.

5.4.2.2.8 Discharges

Discharges include those materials authorized for release into surrounding waters under specific permits and oil spills, which are accidental or unauthorized releases of oil into the marine environment.

Authorized Discharges

Discharges from production drilling would occur over relatively short periods of time. Impacts to water quality from permitted discharges are expected to be localized and short term. Discharge of drilling muds and cuttings during the initial drilling activities is not expected to cause population-level effects, either directly through contact or through affecting prey species. Subsequent drilling wastes would likely be reinjected into a disposal well. Adverse effects to benthic invertebrates that could be important to listed birds would be negligible when compared to their availability in the surrounding areas. Any effects would be localized primarily around the drill rig because of the rapid dilution or deposition of these materials. Because the discharges would be regulated through Section 402 of the CWA, which establishes typical discharge criteria and other mitigation measures, authorized discharges are expected to have a negligible level of effect on listed birds in the Arctic Region OCS.

Oil Spills

Small Spills

Small spills are defined as <1,000 bbl. The average crude-oil spill size is 126 gal (3 bbl) for spills <500 bbl.

Beaufort Sea. An estimated 89 small crude oil spills could occur during the 20-year oil production period, an average of more than four per year (Appendix A, Table A.1-30). The average refined oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined oil spills would occur during the 20-year oil production period (Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur each of the 20 years of production.

Chukchi Sea. An estimated 178 small crude oil spills would occur during the 25-year oil production period (Table A.1-32), an average of more than seven per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 440 refined oil spills would occur during the 25-year oil production period (Table A.1-32), an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur each of the 20 years of production.

It is unknown how many small-volume spills or what total volume would reach areas used by Steller's or spectacled eiders or Kittlitz's murrelets. If these low-volume spills were in close proximity to or within the Ledyard Bay Critical Habitat Unit, a large number of molting spectacled eiders could be contacted and injured or killed. Kittlitz's murrelets or Steller's eiders close to the source of these spills could also be affected, but these birds are at lower densities and substantial adverse effects would not be expected to occur.

Large Spill

Beaufort Sea

The potential for a large spill to contact ESA-protected species in the Beaufort Sea was described in the Beaufort Sea Multiple-sale EIS (USDOI, MMS, 2003). Due to small adjustments in the environmental resource area polygons (size/shape), changes in lease areas, and other model refinements, BOEMRE has updated the assessment for the proposed Beaufort Sea lease sales below.

The spill rate of large platform and pipeline spills during production is 0.58 spills (95% confidence interval = 0.26-0.78) per billion barrels with a 26% chance of one or more large spills occurring over the 20 year life of the production project (Appendix A: Table A.1-26). For the development and production phases, the fate and behavior of a 1,500-bbl crude or condensate spill from a platform, and a 4,600-bbl crude or condensate spill from a pipeline, were evaluated using the SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl crude spill would cover a smaller area (181 km²) (Table A.1-6, USDOI, MMS, 2008) than a 4,600-bbl crude spill (320 km²) (Table A.1-7,) after 30 days. The OSRA uses the center of the spill mass as the contact point, so the chances of either spill contacting specific environmental resource areas would be the same. Because of this similarity, the 4,600-bbl spill is analyzed from this point on.

A 4,600-bbl spill could contact environmental resource areas where Steller's and spectacled eiders and Kittlitz's murrelets may be present (Appendix A). Approximately 40% of a 4,600-bbl spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in fall or under ice in winter would melt out in the following summer. Approximately 69% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km².

Conditional Probabilities. This section discusses the chance that a large oil spill from the Beaufort Sea lease-sale area could contact specific environmental resource areas (ERA) that are important to Steller's and spectacled eiders and Kittlitz's murrelets, assuming a large spill occurs.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting Steller's and spectacled eider and Kittlitz's murrelet habitats assuming a spill occurs. This analysis uses ERAs 1, 2, 8-10, 19, 65, 68, 69, 71-73, 77, and 81. The tables and maps are found in Appendix A. Conditional probabilities assume a large spill occurs (see definition and applications, Appendix A: Section 3.4.1.).

Summer Spill. The following discussion summarizes the results for launch areas (LAs) 1-25 and pipelines (PLs) 1-17 during summer, unless otherwise specified. The OSRA model estimates the chance of a large oil spill contacting any coastal or offshore ERA important to ESA-protected eiders (Tables A.1-13 and 14) from LAs within 30 days is <0.5-52% (Table A.2-65, USDOl, MMS, 2008) and <0.5-44% from PLs (USDOl, MMS, 2008, Table A.2-66), depending on the distance between the resource areas and the source of the spill (Appendix A, Maps A.1-4 and A.1-2a through e.). If groups of land segments are considered, the chance of a large spill contacting the U.S. Beaufort Sea coastline within 30 days is <0.5-63% (Tables A.2-89 and 90 USDOl, MMS, 2008, Map A.1-3d).

The OSRA model estimates a <0.5-54% chance that a large oil spill will contact ERAs important to ESA-listed birds within 180 days from any LA and a <0.5-45% from any PL (Tables A.2-69 and 70, USDOl, MMS, 2008). The highest percent chance of contact is 54% to ERA2, Point Barrow and the Plover Islands, from a large spill originating at LA2 (Table A.2-69, USDOl, MMS, 2008). The chance of contact to this resource area is highest, because the LA and the ERA are in close proximity to or overlap each other (Appendix A, Maps A.1-2a and A.1-4). Other adjacent LAs 1-6 have 13-35% chance of contacting ERA2 within 180 days (Table A.2-69, USDOl, MMS, 2008). The highest percent chance of contact is to ERA68, Harrison Bay, which has a 45% chance of contact from PL9 within 180 days (Table A.2-70 USDOl, MMS, 2008). As with the LAs, the chance of contact with this ERA is highest, because the PL and the ERA are in close proximity to, or overlap, each other (Appendix A, Maps A.1-2a and A.1-4).

Spectacled eiders must stage offshore in the spring if their breeding habitats are unavailable. The spring lead system, ERA19, is used by spectacled eiders during spring (April-June); the highest percent chance of contact to ERA19 is <0.5% from any launch area within 180 days (Table A.2-69, USDOl, MMS, 2008). Similarly, a large spill originating from any pipeline segment would have <0.5% chance of contacting spectacled eiders using ERA19 within 180 days (Table A.2-70, USDOl, MMS, 2008).

Most post-breeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Unit (ERA10). A large spill originating from any launch area or pipeline segment has a <0.5% chance of contacting spectacled eiders in the Critical Habitat Unit during the May-October open-water period within 180 days (Tables A.2-69 and 70, USDOl, MMS, 2008).

Winter Spill. The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during winter, unless otherwise specified. The OSRA model estimates up to a 30% chance that a large oil spill from any LA and up to a 32% chance from a PL will contact ERAs important to ESA-listed eiders within 180 days (Table A.2-117 and A.2-118, USDOl, MMS, 2008). The highest chance of contact from a PL occurs to ERA68, Harrison Bay, which has a 32% chance of contact from PL9 within 180 days. The highest chance of contact (30%) from an LA occurs from LA2 contacting ERA2, Point Barrow and the Plover Islands (Table A.2-117, USDOl, MMS, 2008). The OSRA model estimates the chance of a large spill from LAs 1-6 contacting ERA2 ranges from 10-20% within 180 days. The chance of contact tends to be highest where the LAs and PLs and the ERA are in close proximity to or overlap each other (Table A.2-117 and A.2-118, USDOl, MMS, 2008).

Most post-breeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Unit (ERA 10). A large spill originating from any LA or PL would have a <0.5% chance of contacting the Critical Habitat Unit within 180 days, melting out in spring (Tables A.2-17 and 118, USDOl, MMS, 2008). On an annual basis, a large spill originating from any LA or PL has a <0.5% chance of contacting any ERA important to ESA-listed birds, including the Ledyard Bay Critical Habitat Unit (ERA10), within 180 days (Appendix A, Table A.2-21, USDOl, MMS, 2008).

If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, could contact one or more important habitat areas after ice breakup.

Combined Probabilities. Combined probabilities differ from conditional probabilities in that they do not assume that a large spill has occurred and consolidate non-uniform weighting of launch probabilities into one unit probability. The chance of one or more large spills occurring is multiplied by the chance of a large spill contacting a particular ERA to calculate a combined probability that both would occur simultaneously. Combined probabilities are defined in Appendix A (Section 4.3). The combined probabilities of one or more large spills occurring and contacting ERAs of most concern to threatened bird species are in Table A.1-45). These probabilities are broken into different periods to indicate volatility, weathering, and movement of the spill over time.

Chukchi Sea

The potential for large spills to contact ESA-protected species in the Chukchi Sea was previously described in the Chukchi Sea Lease Sale 193 Final EIS (USDOI, MMS, 2007). Due to small adjustments in the ERA polygons (size/shape), changes in lease areas and other model refinements, we have updated the assessment for the proposed Chukchi Sea Proposed Action below. The results of this analysis are much the same as those for the previous lease sale NEPA analyses in the Chukchi Sea.

The spill rate of large platform and pipeline spills during production is 0.51 (95% confidence interval = 0.32-0.77) per billion barrels, with a 40% chance of one or more large spills occurring over the life of the project (Appendix A, Table A.1-28). For development and production, the fate and behavior of a 1,500-bbl spill from a platform and a 4,600-bbl spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl spill would cover a smaller area (577 km²) (Appendix A, Table A.1-11) than a 4,600-bbl spill (1,008 km²) (Table A.1-12) after 30 days. The OSRA model uses the center of the spill mass as the contact point, so the probabilities of either spill contacting specific ERAs would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed.

A 4,600-bbl spill could contact environmental resource areas where Steller's and spectacled eiders and Kittlitz's murrelets may be present (Appendix A). Approximately 44% of a 4,600-bbl spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 1,008 km². A spill during broken ice in fall or under ice in winter would melt out the following summer. Approximately 55% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 332 km².

Conditional Probabilities. This section discusses the chance that a large oil spill from the Chukchi Sea Proposed Action area could contact specific environmental resource areas that are important to Steller's and spectacled eiders and Kittlitz's murrelets, assuming a hypothetical large spill occurs.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting Steller's and spectacled eider and Kittlitz's murrelet habitats assuming a spill occurs. The ERAs 1, 2, 8, 9, 10, 19, 65, 68, 69, 71, 72, 73, 77 and 81 are used in this analysis. Table A.1-14 explains these ERAs and Maps A.1-2a- A.1-2e show their spatial locations. Conditional probabilities are based on the assumption that a large spill occurred (see definition and applications, Appendix A: Section 3.4.1).

Summer Spill. The following discussion summarizes the results for LAs 1-15 and PLs 1-11 during summer unless otherwise specified. The OSRA model estimates a <0.5-42% chance that a large spill starting at any launch area will contact ERAs important to ESA-listed birds within 180 days, and a <0.5-56% chance from a pipeline (Table A.3-35, USDOI, MMS, 2008). The highest chance of contact from a launch area is 42% to ERA10 (Ledyard Bay Spectacled Eider Critical Habitat) from LA10. The chance of contact in this resource area is highest, because the launch area and the environmental resource area are in close proximity to or overlap each other (maps, Appendix A). For pipelines, the highest chance of contact to ERA10 is from PL6, which has a 56% chance of contact. As with the launch areas, the chance of contact in this resource area is highest, because the OSRA

model's pipeline segments and the environmental resource area are in close proximity to or overlap each other.

Spectacled eiders must stage offshore in the spring if their breeding habitats are unavailable. The ERA19 represents the spring lead system used by spectacled eiders during spring (April-June), and the highest percent chance of contacting ERA19 is 9% from any launch area within 180 days (Table A.3-35, USDO, MMS, 2008). Similarly, a spill originating from PLs 6, 9, or 11 has a 12-14% chance of contacting ERA19 within 180 days (Table A.3-35, USDO, MMS, 2008).

Most post-breeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Unit (ERA10). A large spill from LAs 9, 10, and 11 has an 11%, 42%, and 29% chance of contacting the critical habitat unit, which spectacled eiders use during the May-October open-water period (Table A.3-35, USDO, MMS, 2008).

As Steller's eiders occur in low numbers, specific coastal areas and nearshore waters important to Steller's eiders in the Beaufort Sea have not been identified. Coastal waters important to spectacled eiders include Harrison Bay/Colville River Delta (ERA69), Simpson Lagoon (ERA71), and the Plover Islands (ERA2). The highest chance of contacting ERAs 69, 71, and 72 is 36%, 11%, and 52% from LAs 8, 10, and 2, respectively, within 30 days. This suggests a high percent chance of contact, and it is possible that mortality of low hundreds of spectacled eiders could occur. As noted, this analysis is only for purposes of modeling and to determine which areas would have the highest chance of contact; the foregoing percent chances of contact assume that a large spill occurs and no oil spill response is included in the oil spill trajectory simulation.

Winter Spill. The following discussion summarizes the results for LAs 1-15 and PLs 1-11 during winter, unless otherwise specified. The OSRA model estimates a <0.5-26% chance that a large spill starting at any launch area contacts ERAs important to ESA-listed eiders within 180 days, and a <0.5-35% from a pipeline (Table A.3-59 and maps, USDO, MMS, 2008). The highest percent chance of contact from a launch area occurs at ERA19, the spring lead system (April-June), which has a 26% chance of contact from LA10 and 35% from P9. The chance of contact in this resource area is highest, because launch areas or pipeline segments and the environmental resource area in the OSRA model are in close proximity to or overlap each other (Table A.3-59 and maps, USDO, MMS, 2008).

Most post-breeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Unit (ERA10). The OSRA model estimates a spill from LA10 or PL6 has a 10% or 13% chance of contacting ERA10 during winter, melting out in the spring. On an annual basis, a large spill from LA10 or PL6 has a 23% and 31% chance, respectively, of contacting ERA10 within 180 days (Table A.3-5, USDO, MMS, 2008).

If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, could contact one or more important habitat areas after ice breakup.

Combined Probabilities. Combined probabilities differ from conditional probabilities in that they do not assume that a large spill has occurred and consolidate non-uniform weighting of launch probabilities into one unit probability. The chance of one or more large spills occurring is multiplied by the chance of a large spill contacting a particular environmental resource area to estimate a combined probability that both would occur simultaneously. Combined probabilities are defined in Appendix A (Section 4.3). The combined probabilities of one or more large spills occurring and contacting ERAs of most concern to threatened bird species are summarized in Table A.1-46. These probabilities are broken into different periods to indicate volatility, weathering, and movement of the spill over time.

If the chance of large spill occurrence is incorporated, the combined probability of one or more large oil spills occurring and contacting any ERA north of the spectacled eider breeding range (ERAs 2, 8, 9, 71-73, 77, 78, and 96; Appendix A, Maps A.1-2a through A.1-2e) within 30 days is <1% over the

20-year production life of the Proposed Action (Table A.2-157). While more development may be expected to occur in the vicinity of Prudhoe Bay because of the proximity to primary support facilities, the combined probability of contacting ERAs important to ESA-listed birds offshore of this area does not exceed 1%. Flocks foraging inside the barrier islands (~50% of the coastline has adjacent islands) are protected to some extent from oil-spill contact.

Spill-Response Activities. None of the conditional or combined probabilities factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil production.

Activities such as hazing and other human activities (e.g., vessel and aircraft traffic) could impact threatened eiders, Kittlitz's murrelets, and yellow-billed loons. Hazing may have limited success during spring when migrants occupy open water ice leads. The hazing effect of cleanup activity or actively hazing birds out of ice leads that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy. Cleanup activities in leads during May and open water in July through September are likely to adversely affect listed eiders and candidate birds.

The presence of large numbers of cleanup workers, boats, and additional aircraft is likely to displace spectacled and Steller's eiders from affected offshore, nearshore, and/or coastal habitats during open-water periods for one to several seasons. Although little direct mortality from cleanup activity is likely, predators may take some eggs or young while females are displaced off their nests if located near a site of operation. Disturbance during the initial season, possibly lasting 6 months, is expected to be frequent in some areas. Cleanup in coastal areas late in the breeding season may disturb small flocks of flightless broods, and some may be displaced from favored habitats, expending energy stores accumulated for molt/migration. Survival and fitness of individuals may be affected to some extent, but this disturbance would not be likely to result in more than a minor effect. Again, this assumes that a spill occurs and that an area important to these birds is affected when they are there.

Oil-spill response could originate from as far away as Deadhorse, about 150 mi east of Barrow. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with FWS and State officials on wildlife-management activities in the event of a spill. In an actual spill, the two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed hazing activities and monitor their impact on birds. As a member of the team, FWS personnel would be largely responsible for providing critical information affecting response activities to protect listed birds in the event of a spill.

Oil-spill-response plans typically do not spell out specific wildlife-response actions. They typically identify the resources at risk and refer to the appropriate tactics. The response contractor also can contract with other response organizations to augment animal hazing and response activities. The response contractor would be expected to have an inventory of bird scare devices in addition to the Breco buoys (air cannons, guns, vessels, pyrotechnics, and visual devices) to deter birds from entering the spill area and would be assumed to cycle their use to ensure that the birds do not habituate to their effect.

For purposes of evaluating the potential impact of a large spill on threatened or candidate bird species, oil-spill-response in the Chukchi Sea is assumed to be ineffective due to the unpredictability of response time, proximity of the launch area(s) to bird habitats, certain environmental conditions (e.g., broken ice), and the large number of birds that could be impacted in a brief time period (<36 hours).

Prey Reduction or Contamination. Local reduction or contamination of food sources could reduce survival or reproductive success of the portion of populations occupying or nesting in the local area affected. This generally is not likely to affect a large proportion of Steller's or spectacled eider

populations, because they exhibit a dispersed breeding distribution. However, it could be more serious if these populations are experiencing a population decline. Lowered food intake may slow the completion of growth in young birds, the replacement of female energy reserves used during nesting, and energy storage for migration of all individuals. However, the contamination of some local habitat areas is not likely to affect a large proportion of the population, because they are likely to have access to alternative foraging habitat similar in appearance and with similar prey organisms present that is widely distributed in the region (for details see Section III.C.2.c, USDOl, MMS, 2002).

Anticipated Mortality from an Oil Spill

Beaufort Sea. A large oil spill occurring in the Beaufort Sea during summer or fall periods most likely would contact broods of spectacled or Steller's eiders in certain open-water marine habitats. Some of these areas in the Beaufort Sea have been identified as the Plover Islands off Barrow, Simpson Lagoon, and Harrison Bay, which generally are north, offshore of nesting areas. The percent chance of contact is lowered by species being concentrated in relatively few scattered flocks during the brief period present (Stehn and Platte, 2000: Table 1; Fischer, Tiplady, and Larned, 2002). Stehn and Platte (2000) concluded that the spectacled eider was one of the species least likely to have a high proportion of their populations exposed to oil because of their widespread distribution or tendency to occur farther from the spill source, the source being the Liberty development (then proposed for Foggy Island Bay).

Stehn and Platte (2000) modeled the potential mortality to waterbirds resulting from a hypothetical spill originating from the Liberty Development in Foggy Island Bay. The authors estimated an average population of 540 spectacled eiders occurred in this area in July. In this example an average number of two (range 0-52) spectacled eiders would be exposed to oil from a 5,912-bbl spill. This would represent 0.003% of the estimated population vulnerable at that time. Calculated mortality for a similar spill during August was 0.00 (Stehn and Platte 2000: Table 5).

While the Stehn and Platte (2000) example illustrates the low potential for spectacled eiders to be affected by a hypothetical spill, potential for more severe impacts would increase if launch areas originated farther west, where more eider broods were rearing or moving through en route to a molting area in the Chukchi Sea. The anticipated population effect likely would be low to moderate, even if mortality were to approximate 125 birds, because most of these birds would be first-year birds that have a higher natural mortality rate; this number represents a small proportion of the entire North Slope fall population ($125/33,848 = 0.37\%$). The spectacled eider population appears to have stabilized over the 2000-2006 time period (Stehn, Larned, Fischer et al., 2006), and a growth rate of 1.016 could be expected to allow recovery of these lost birds in less than a generation. Furthermore, these relatively small losses may be difficult to separate from natural variation in population numbers. This has been found for other waterbird populations under similar circumstances (for details see Section III.C.2.a[2] in USDOl, MMS, 2002).

Chukchi Sea. Eiders returning to the breeding grounds in spring often encounter sea ice in offshore areas and must stage in the Chukchi Sea before heading overland to nest sites. An excellent map depicting spectacled eider nesting areas is in Larned, Stehn, and Platte (2006: Figure 17). After breeding, the males often return overland to open waters in the Chukchi Sea. Once the chicks are flight capable, the females and broods move west out of the Beaufort Sea to molting areas in the Chukchi Sea, particularly Ledyard Bay. Bird mortality associated with an oil spill is likely to reflect local population size and vulnerability determined by seasonal habitat use and stage of annual cycle at the time of contact (for example, molting versus non-molting).

An oil spill contacting the Ledyard Bay Critical Habitat Unit (ERA10) during the open-water period could contact tens of thousands of molting eiders. As many as 33,000 eiders, including the entire cohort of successfully breeding females and their young, use the Ledyard Bay molting area at one time. The loss of all or part of the breeding female spectacled eiders of the Arctic Coastal Plain would result in large-scale, adverse population-level effects. Oil-spill modeling, however, indicates that the

risk of a spill of a magnitude to jeopardize the continued existence of spectacled eiders to be a low-likelihood event.

For many of the same reasons, a spill contacting the spring lead system could affect a relatively large proportion of the Steller's eider population staging en route to the breeding grounds. A spill of this magnitude would result in a large-scale, adverse population-level effect on this species. Oil-spill modeling, however, indicates that the risk of a spill of this magnitude is a low-likelihood event.

Conclusion, Spill Effects

Beaufort Sea. To put the risk of a large spill having population-level effects in perspective, one has to consider several variables. First, to ever have an oil spill, production would have to occur. The most likely scenario states the optimistic probability of a successful commercial find ranged from 17% and 50%, indicating that production is unlikely (USDOI, MMS, 2003). Second, the location of the oil or gas find and subsequent development platform could influence the probability that a spill would occur as well as the probability that it would reach resource areas important to threatened or candidate bird species when the species are present, or, in the case of a winter spill, when those birds return. Finally, the number and sex/age of threatened or candidate birds affected would have differing degrees of population-level effects, from a few birds in an area to all birds in an area during particular time periods. Given the stated low chance of successful oil field development, the low likelihood that a large spill would occur, and the low percent chance that a large spill would reach a resource area important to murrelets and threatened eiders, an adverse effect of this magnitude appears to be a low-likelihood event.

Anticipated mortality associated with these modeled events would represent <1% of the October North Slope spectacled eider population. Consequently, the ITL is consistent with the previous lease-sale Section 7 consultation documents:

...the low probability of such an event, combined with the uncertainty of the location of the spill, and the seasonal nature of the resources inhabiting the area, make it highly unlikely that a large oil spill would contact a threatened eider. Spectacled and Steller's eiders are present on the North Slope for only 3-5 months out of the year. Even if an eider were present in the vicinity of an oil spill, it might not be contacted by the oil due to avoidance behavior, ice conditions or weather patterns. Furthermore, the MMS [BOEMRE] requires companies to have and implement oil-spill-response plans to help prevent oil from reaching critical areas and to remove oil from the environment.

If a commercially viable resource discovery is made and is considered for development, BOEMRE must complete Section 7 consultation with the FWS on a development and production plan. As with the Sale 193 final EIS (see Information to Lessees, Appendix F, USDOI, MMS, 2008), "...a future project would not be authorized by MMS [BOEMRE] if it results in jeopardy or adverse modification of designated critical habitat as determined by FWS." BOEMRE believes that this condition will help industry incorporate stringent measures into their plans that avoid the risk of population-level effects on ESA-protected species.

Small spills are not modeled by the trajectory analysis but could adversely affect small numbers of Steller's eiders, Kittlitz's murrelets, and yellow-billed loons. Although difficult to state with any certainty, a small-volume spill in close proximity to a large, dense flock of molting spectacled eiders could result in adverse impacts to perhaps several hundred eiders, and maybe more. Depending on the chronic nature of small spills, this situation could occur repeatedly. There appears to be little percent chance of this occurring from a large spill originating in the Beaufort Sea reaching the spring lead system or Ledyard Bay, where large flocks of eiders and small numbers of candidate species may be present. Similarly, smaller spills would have even less likelihood of reaching these areas. Oil-spill modeling indicates that the percent chance of a spill of a magnitude that could jeopardize the continued existence of spectacled eiders on the North Slope is extremely low.

Considering the low probability of a large oil spill coupled with a variety of other factors that would need to be satisfied to result in mortality, BOEMRE anticipates that it is highly improbable that listed eider mortality would result from oil spills associated with the Proposed Action and a negligible level of effect to ESA-protected birds is anticipated.

Chukchi Sea. A large oil spill contacting the Ledyard Bay Critical Habitat Unit (ERA10) during the open water period could contact as many as 33,000 eiders, including the entire cohort of successfully breeding females and their young, using the Ledyard Bay molting area at one time. The loss of all or part of the breeding female spectacled eiders of the Arctic Coastal Plain would be anticipated to result in large-scale adverse population-level effects.

To put the risk of a large spill having population-level impacts in perspective, one has to consider several variables. First of all, to ever have an oil spill, production would have to occur. The most likely scenario states the probability of a successful commercial find is <10%, indicating that production is unlikely (USDOI, MMS, 2007). Secondly, the location of the oil or gas find and subsequent development platform could influence the probability that a spill would occur as well as the probability that it would reach resource areas important to threatened or candidate bird species when the species are present or, in the case of a winter spill, when those birds return. Finally, the number and sex/age of threatened or candidate birds affected would have differing degrees of population-level effects, from a few birds in an area to all birds in an area during particular time periods. Given the stated low probability for successful oil-field development, the probability that a large spill would occur, and the probability that a large spill would reach a resource area important to threatened eiders, Kittlitz's murrelets, and yellow-billed loons, an adverse effect of this magnitude appears to be a low-likelihood event.

For many of the same reasons, a large spill contacting the spring lead system could affect a relatively large proportion of the Steller's eider population staging en route to the breeding grounds. A spill of this magnitude would result in a large-scale, adverse population-level effect on this species. Oil-spill modeling, however, indicates that the risk of a spill of this magnitude is a relatively low-likelihood event.

If a commercially viable resource discovery is made and is considered for development and production, BOEMRE must complete Section 7 consultation with FWS. As with the Lease Sale 193 final EIS (see Information to Lessees, Appendix F, USDOI, MMS, 2008), "...a future project would not be authorized by MMS [BOEMRE] if it results in jeopardy or adverse modification of designated critical habitat as determined by FWS." BOEMRE believes that this condition will help industry incorporate stringent spill prevention measures into their plans that avoid the risk of population-level effects on ESA-protected species in the Chukchi Sea.

Small spills are not modeled by the trajectory analysis, but could adversely affect a moderate number of Steller's eiders, Kittlitz's murrelets, or yellow-billed loons. Although difficult to state with any certainty, a small-volume spill in close proximity to a large, dense flock of molting spectacled eiders could result in adverse impacts to perhaps several hundred eiders, maybe more. Depending on the chronic nature of small spills, this situation could occur repeatedly. There appears to be a relatively higher percent chance of this occurring from a large spill originating in the Chukchi Sea reaching the spring lead system or Ledyard Bay, where large flocks of eiders may be present. Similarly, smaller spills, despite having less mobility and persistence, would have a greater likelihood of reaching these nearby areas. Oil-spill modeling indicates that the percent chance of a spill of a magnitude that could jeopardize the continued existence of spectacled eiders on the North Slope is highest where launch areas or pipeline segments are in close proximity to important eider habitats.

Considering the low probability of a large oil spill occurring, coupled with a variety of other factors that would need to be satisfied to result in mortality, BOEMRE anticipates that it is improbable that listed eider mortality would result from oil spills associated with the Proposed Action and a negligible level of effect is anticipated.

5.4.3 Cumulative Effect

Effects of Climate Change on Coastal and Marine Birds

Scientific and public interest in the Arctic is at an all time high owing to a multitude of warming-induced changes now under way and a growing appreciation for the region's importance to the global climate system. Temperatures over Arctic land areas have risen and continue to rise at roughly twice the rate of the rest of the world. The implications of climate change on coastal and marine birds are impossible to predict with any precision, but some trends are evident and are anticipated to continue. This section briefly describes likely ongoing effects on coastal and marine birds from changes in oceanographic processes and sea ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise.

How these factors influence physical conditions of the spring lead system or the LBCHU are of particular concern. The ESA-protected bird species likely will face altered conditions, and their traditional food sources will be lost or become available at different times of the year, potentially threatening long-established relationships that are essential to species survival. Changes in oceanographic processes and sea-ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise could lead to alterations of the historical spring lead system or the importance of the LBCHU.

Changes in Oceanographic Processes and Sea-Ice Distribution

In recent decades, the Arctic has witnessed significant climatic and other environmental changes including notable decreases in the extent of sea ice. The sea ice is thinner, begins melting sooner, forms later, and retreats farther from shore each year. Because of this, and in conjunction with other related factors, it is commonly perceived that the Chukchi Sea is changing to become more like the Bering Sea, and the western Beaufort Sea is changing to become more like the Chukchi Sea.

To understand ongoing changes in the Arctic region it may be helpful to look at similar situations in the Bering Sea. Evidence shows that the Bering Sea is changing (Grebmeier et al., 2006, 2008). Some of these changes probably have benefited Arctic-nesting birds, because some important prey resources likely have increased, especially at critical times in their lifecycle. For example, Springer, Roseneau, Murphy et al. (1984) concluded that a pattern of climatic cooling in the early 1970s followed by warming in the second half of the decade caused annual differences in the extent and duration of sea ice, and apparently in the spatial and temporal development of Alaskan Coastal Water, a major oceanographic feature of the Bering-Chukchi shelf. Fluctuations in the physical environment have led to changes in fish populations through direct physiological and behavioral effects, or indirectly by altering the abundance of important zooplankton prey populations (Springer, Roseneau, Murphy et al., 1984). Variability in the reproductive success of murres and kittiwakes studied at Cape Thompson and Cape Lisburne corresponded with the apparent changes in fish stocks.

On the other hand, prey resources important to other birds in the Chukchi Sea may shift north and become less abundant during important life stages. For example, about 500,000 seabirds from Cape Lisburne to Cape Thompson forage in Ledyard Bay for most of the summer. Similarly, hundreds of thousands of sea ducks reportedly feed on benthic invertebrates in Ledyard Bay during the spring and fall for staging and molting. The total annual removal of biomass from Ledyard Bay must be considerable, yet the processes supporting such sustained productivity are not known. The oceanographic processes affecting Ledyard Bay could be influenced by northward movements of Bering Sea currents and the distribution of sea ice in the spring. Oceanographic processes that have resulted in changes to the productivity in Ledyard Bay have affected nearly a million birds, but effects on bird populations have not been documented or studied.

Mild winters in the Bering Sea may be favoring those species that often contend with harsh environmental conditions there. During mild winters, energy that would have gone to contend with harsh environmental extremes could have been directed towards improving the condition of the

female. Lehtikoinen, Kilpi, and Ost (2006) demonstrated that common eiders (*Somateria mollissima*) wintering off Finland had greater breeding success following mild winters. In this study, female brood-rearing behavior was linked to offspring survival and condition. Female condition was linked to offspring quality in terms of yearly survival. Females could be in poorer condition after a severe winter and would not allocate as much resources to breeding.

Implications for other coastal and marine birds include a continuation of trends observed for several species, most notably birds that typically forage on resources at the ice edge, such as black guillemots and ivory gulls. These species must either make longer forays to the ice edge from their breeding sites or change to alternative prey, two options that likely would result in lowered reproductive performance. Similar changes could occur to those species reliant on the productivity of nearshore waters in the spring, because those productive zones may be lost or displaced (see Section 3.3.1). Birds unable to replenish or build energy stores prior to breeding could experience decreased survival or reproductive success. Decreasing nearshore biotic productivity also could degrade the quality of brood-rearing areas.

Duration of Snow and Ice Cover

Similar to sea ice, seasonal river- and lake-ice cover is breaking up earlier each year, and the open-water season is longer. Lake-dependent species, such as loons or swans, could benefit because their young would have more time to become flight capable.

Thinner snow cover over tundra would melt earlier, allowing Arctic-nesting birds to begin nesting sooner. Arctic-nesting birds have adapted to a narrow range of nest-initiation dates. Birds typically are able to start nesting when sites first come available; they may not be able to raise a brood successfully if nesting is delayed. On the other hand, earlier lay dates observed in black guillemots may provide parents greater access to the ice edge before it recedes away from the nesting colony (Friends of Cooper Island, 2007).

Earlier nesting also could benefit many other species nesting on the tundra if other components of the food chain are on the same phenology. Birds likely are unable to successfully shift their nesting phenology outside of the normal range, if high-value food resources are not available at critical times (i.e., interacting predator-prey species react differently to warming, referred to as “trophic asynchrony”). Shifts to earlier laying dates could result in overall decreased clutch size or chick survival, if nutritional needs are outside the period of favorable food conditions (Visser, Both, and Lambrechts, 2004). In this case, climate change could lead to mistiming and failure of reproduction, and certain marine and coastal bird populations could decline.

Distribution of Wetlands and Lakes

Scientific evidence indicates that tundra habitats have changed and will continue to change. Perhaps the most important changes to Arctic vegetation are expected in the form of expanding and retreating lakes and wetlands. Much of the ACP is underlain with permafrost. Permafrost close to the surface plays a major role in freshwater systems, because it often maintains lakes and wetlands above an impermeable frost table, which limits the water storage capabilities of the subsurface. Permafrost is warming along with the rest of the Arctic. Scientific models predict that large-scale changes in permafrost are likely, and significant permafrost degradation has been reported in some locations.

As warming continues, some regions of the Arctic will see shifts in permafrost distribution and deepening of the active layer, accompanied by changes in vegetation. The active layer is the topmost layer of permafrost that thaws during the summer, allowing organic processes to occur. As the active layer becomes saturated, it is prone to collapse (mass wasting). Permafrost collapse tends to result in the slumping of the soil surface and flooding, followed by a complete change in vegetation, soil structure, and many other important aspects of these ecosystems. Initially, over an unknown time period, flooding results in a boost of vegetative productivity and the expansion of wetlands and shallow lakes. Over time, however, as the permafrost continues to melt and infiltration increases,

shallow summer groundwater tables continue to drop and subsequent drying of wetlands and drainage of lakes occurs.

Recent studies using satellite and field data have revealed remarkable changes in the number and total area of Arctic lakes and wetlands in just the past few decades. A preliminary assessment is that they are growing in northern areas of continuous permafrost, but disappearing farther south. Lakes in areas of continuous and discontinuous permafrost have experienced substantial shrinkage, likely due to permafrost degradation allowing them to drain to the subsurface. A study of Arctic lakes in Siberia observed that many lakes have disappeared or shrunk in the last 30-40 years (Smith et al., 2005).

The unique character of ponds and lakes is a result of the long frozen period, which affects nutrient status and gas exchange during the cold season and during thaw. Climate warming could change the characteristics of waterbodies that presently freeze to the bottom and can result in fundamental changes in their limnological characteristics. A lengthening of the growing season and warmer water temperature would affect the chemical, mineral, and nutrient status of lakes and most likely have deleterious effects on the food chain (Rouse et al., 2007). Smol and Douglas (2007) reported that not all lakes are disappearing due to degradation of permafrost, but that some lakes have become desiccated as a consequence of increasing evaporation/precipitation ratios, another outcome of climate change.

Sea Level Rise

Sea level rise is regarded as one of the more certain consequences of global climate change. During the past 100 years, sea level has risen at an average rate of about 1-2 millimeters (mm) per year (or 4-8 inches [in] per century [USDOI, USGS, 2007b; Titus and Narayanan, 1995]). The projected two- to five-fold acceleration of global average sea level rise during the next 100 years will inundate low-lying coastal wetland habitats that cannot move inland or accrete sediment vertically at a rate that equals or exceeds sea level rise.

Coastal wetlands are particularly vulnerable to sea level rise associated with increasing global temperatures. Freshwater systems in the Arctic are dominated by a low-energy environment and cold-region processes. Changing rates and timing of river runoff will alter the temperature, salinity, and oxygen levels of coastal estuaries. Inundation by rising sea levels, intensification of storms, and higher storm surges threaten coastal estuaries and wetlands. For many of these systems to persist, a continued input of suspended sediment from inflowing streams and rivers is required to allow for soil accretion.

The potential loss of coastal marshes could result in substantial impacts to birds that rely on unique resources provided at these uncommon sites. Johnson (1993), for example, demonstrated that Kasegaluk Lagoon is an important autumn staging area for Pacific Flyway Brant. Brant concentrate in Kasegaluk Lagoon while staging for southward migrations, foraging on abundant aquatic plants, such as *Ulva*. Migrating species will face altered conditions and their traditional food sources will be lost or become available at different times of the year, potentially threatening long-established relationships that are essential to species survival.

5.4.4 Determination of Effect

The purpose of this Biological Evaluation is to determine the effects of the Proposed Action. The effects of the action on threatened or endangered species under Section 7 of the Endangered Species Act species are considered along with the environmental baseline (Section 4.0) and predicted cumulative effects (Section 5.4). This section considers the following categories.

- The proposed actions would have no effect on the listed species.
- The proposed actions may affect the listed species. Two categories:
 - The proposed action is likely to adversely affect the listed species.
 - The proposed action is not likely to adversely affect the listed species.

It is determined through this analysis that the Proposed Action likely would have the following effects, as described by the ESA, on Steller's and spectacled eiders, Kittlitz's murrelets, yellow-billed loons, and designated critical habitat:

Spectacled Eider

The Proposed Action could result in activities in new areas that may affect listed eiders in the Chukchi Sea and Beaufort Sea (the Arctic Region OCS). Comprehensive mitigation measures will avoid or minimize potential adverse impacts to listed eider species, but long-term disturbance could still occur in sensitive habitats. Furthermore, a small number of spectacled eiders could still be killed by their collision with exploration structures and these mortalities are likely to adversely affect spectacled eiders. This conclusion is based on BOEMRE considering potential levels of collision mortality to not be discountable or insignificant as defined by the ESA.

Activities associated with development and production would likely occur at levels near those for exploration. Duration of development activity is likely to span a period of several years. Based on a hypothetical development and production scenario in the Arctic Region OCS, these activities are likely to result in adverse effects to, but are not likely to jeopardize the continued existence of, the Steller's eider. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Further incremental consultation would be necessary at the time development and production plans are proposed.

Ledyard Bay Critical Habitat Unit

It is determined through this biological evaluation that the proposed exploration and development and production of federal leases on the Chukchi Sea and Beaufort Sea OCS will likely have the following effect on threatened or endangered birds and critical habitat:

Activities associated with development and production would likely occur at levels near those for exploration. Duration of development activity is likely to span a period of several years. Based on a hypothetical development and production scenario in the Arctic Region OCS, these activities are not likely to result in a permanent adverse modification of this designated critical habitat, because any production facilities exposed above the seafloor eventually would be removed. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Further incremental consultation would be necessary at the time development and production plans are proposed.

Steller's Eider

The Proposed Action could result in activities in new areas that may affect listed eiders in the Chukchi Sea and Beaufort Sea (the Arctic Region OCS). Comprehensive mitigation measures will avoid or minimize potential adverse impacts to Steller's eiders, but long-term disturbance could still occur in sensitive habitats. Furthermore, a small number of Steller's eiders could still be killed by their collision with exploration structures and these mortalities are likely to adversely affect Steller's eiders. This conclusion is based on BOEMRE considering potential levels of collision mortality to not be discountable or insignificant as defined by the ESA.

Activities associated with development and production would likely occur at levels near those for exploration. Duration of development activity is likely to span a period of several years. Based on a hypothetical development and production scenario in the Arctic Region OCS, these activities are likely to result in adverse effects to, but are not likely to jeopardize the continued existence of, the Steller's eider. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Further incremental consultation would be necessary at the time development and production plans are proposed.

Kittlitz's Murrelet

The Proposed Action could result in activities in new areas that may affect the Kittlitz's murrelet in the Chukchi Sea and Beaufort Sea (the Arctic Region OCS). Comprehensive mitigation measures will avoid or minimize potential adverse impacts to Kittlitz's murrelet, but the Proposed Action is not likely to adversely affect the Kittlitz's murrelet in the Arctic Region OCS.

Activities associated with development and production would likely occur at levels near those for exploration. Duration of development activity is likely to span a period of several years. Based on a hypothetical development and production scenario in the Arctic Region OCS, these activities are likely to result in adverse effects to, but are not likely to jeopardize the continued existence of, the Kittlitz's murrelet. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Further incremental consultation would be necessary at the time development and production plans are proposed.

Yellow-billed Loon

The Proposed Action could result in activities in new areas that may affect yellow-billed loons in the Chukchi Sea and Beaufort Sea (the Arctic Region OCS). Comprehensive mitigation measures will avoid or minimize potential adverse impacts to yellow-billed loons, but the Proposed Action is not likely to adversely affect the yellow-billed loon in the Arctic Region OCS.

Activities associated with development and production would likely occur at levels near those for exploration. Duration of development activity is likely to span a period of several years. Based on a hypothetical development and production scenario in the Arctic Region OCS, these activities are likely to result in adverse effects to, but are not likely to jeopardize the continued existence of, the yellow-billed loon. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Further incremental consultation would be necessary at the time development and production plans are proposed.

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APPENDIX A

A.1 Oil-Spill Information, Models, and Assumptions

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A.1 Information, Models, and Assumptions BOEMRE Used to Analyze the Effects of Accidental Oil Spills

This appendix synthesizes the oil spill analyses in previously published EISs and EAs covering oil and gas leasing, geological and geophysical (G&G) activities and exploration plans in the Beaufort and Chukchi Sea Planning Areas to provide an oil spill scenario framework for purposes of analysis in this biological evaluation (Table 1). It supplements and updates those analyses for which new information has become available since their publication.

Table 1 NEPA documents used to synthesize oil spill information and analysis in the Arctic OCS Region for this BE.

Spill Size Category	Phase	Beaufort Sea	Chukchi Sea
Small (<1,000 bbl)	Exploration	2012 Camden Bay Revised EP EA 2010 Camden Bay EP EA and 2010 ION G&G Survey EA 2008 Arctic Multiple-Sale DEIS 2003 Beaufort Multiple Sale FEIS	2010 Chukchi Sea EP EA 2010 Statoil G&G Survey EA 2008 Arctic Multiple-Sale DEIS 2007 Sale 193 FEIS
	Development and Production	2008 Arctic Multiple-Sale DEIS 2003 Beaufort Multiple Sale FEIS	2008 Arctic Multiple-Sale DEIS 2007 Sale 193 FEIS
Large (≥1,000 bbl)	Exploration	No large spills estimated	No large spills estimates
	Development and Production	2008 Arctic Multiple-Sale DEIS 2003 Beaufort Multiple Sale FEIS	2008 Arctic Multiple-Sale DEIS 2007 Sale 193 FEIS
Very Large (≥150,000 bbl)	Exploration, Development and Production	2003 Beaufort Multiple Sale FEIS	2011 Sale 193 Final SEIS

Referenced below are important source documents for the oil spill analysis summarized in this appendix (Table 1). The documents are located on the BOEMRE website at http://alaska.boemre.gov/ref/eis_ea.htm and can be downloaded to research and understand the oil spill analysis information in further detail.

- USDO, MMS. 2003. Beaufort Sea Planning Area Sales 186, 195, and 202 Oil and Gas Lease Sale Final EIS. (Beaufort Multiple-Sale FEIS)
- USDO, MMS. 2006. Proposed OCS Lease Sale 202 Beaufort Sea Planning Area Environmental Assessment. (Sale 202 EA)
- USDO, MMS. 2007. Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea Final EIS. (Sale 193 FEIS)
- USDO, MMS. 2008. Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 Draft EIS. OCS EIS/EA MMS 2008-055. Anchorage, AK: USDO, MMS, Alaska OCS Region. (Arctic Multiple-Sale DEIS)
- USDO, MMS. 2009a. Environmental Assessment: Shell Offshore, Inc. 2010 Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska. OCS EIS/EA MMS 2009-052. Alaska OCS Region, Anchorage, AK. (2010 Camden Bay EP EA)
- USDO, MMS. 2009b. Environmental Assessment: Shell Gulf of Mexico, Inc. 2010 Exploration Drilling Program, Burger, Crackerjack, and SW Shoebill Prospects, Chukchi Sea Outer Continental Shelf, Alaska. OCS EIS/EA MMS 2009-061. Alaska OCS Region, Anchorage, AK. (2010 Chukchi Sea EP EA)
- USDO, BOEMRE. 2010a. Environmental Assessment: Statoil USA E&P Inc. 2010 Chukchi Sea Seismic Survey. (2010 Statoil G&G Survey EA)
- USDO, BOEMRE. 2010b. Environmental Assessment Beaufort Sea and Chukchi Sea Planning Areas ION Geophysical, Inc. Geological and Geophysical Seismic Surveys Beaufort and Chukchi Seas. (2010 ION G&G Survey EA)

- USDOl, BOEMRE, 2011a. Beaufort Sea Planning Area Shell Offshore Inc. 2012 Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Beaufort Sea. (2012 Camden Bay Revised EP EA).
- USDOl, BOEMRE. 2011b. Chukchi Sea Planning Area Oil and Gas Lease Sale 193 In the Chukchi Sea, Alaska. Final Supplemental Environmental Impact Statement. (Sale 193 Final SEIS)

BOEMRE analyzed hypothetical crude, condensate, or refined oil spills from oil and gas activities and their relative impact to environmental resource areas and the coastline that could result from offshore oil exploration or development in the Beaufort Sea or Chukchi Sea OCS areas. BOEMRE made a set of assumptions that collectively form a scenario to analyze the effects of oil spills from oil and gas activities in a consistent manner throughout previous NEPA documents.

Oil spills are broken down into three general spill-size categories and two general phases of operations. These divisions reflect a difference in what information about the spills is derived and used. The oil-spill analysis considers three general spill-size categories: (1) large spills, those greater than or equal to (\geq) 1,000 barrels (bbl), meaning that 1,000 bbl is the threshold size; (2) small spills, those less than ($<$) 1,000 bbl and (3) very large spills, those $\geq 150,000$ bbl. The oil-spill analysis considers two general operation categories: (1) exploration and (2) development and production.

Large and very large spills are those spills that are $\geq 1,000$ bbl and would persist on the water long enough to follow its path in a trajectory analysis. A small spill would not be expected to persist on the water long enough to follow its path in a trajectory analysis. In this appendix, the information, models, and assumptions of large spills are discussed in Sections 1 through 4. The information about small spills is discussed in Section 5. Large spills are assumed to occur during development and production. Small spills are assumed to occur both during exploration and development and production. Very large spills are not assumed to occur and are discussed in Section 6.

To evaluate the effect of a large oil spill, BOEMRE estimates information regarding the type of oil, the general source of a large oil spill, the location and size of a large spill, the chemistry of the oil, how the oil will weather, how long it will remain, and where it may go. BOEMRE also estimates the mean number of large spills and the chance of one or more large spills occurring over the entire production life of the development. BOEMRE simulates the paths large oil spills take in order to estimate the chance of a large spill contacting a specific resource area, and BOEMRE combines the chance of a spill contacting specific areas with the chance of one or more large spills occurring to estimate the chance of one or more large spills occurring and contacting specific areas over the life of production.

Estimating large oil-spill occurrence or large oil-spill contact is an exercise in probability.

Uncertainty exists regarding whether exploration or development will occur at all and, if it does, the location, number, and size of large oil spill(s) and the wind, ice, and current conditions at the time of a spill(s). Some amount of uncertainty exists simply because it is difficult to predict events 15-40 years into the future.

For small spills, BOEMRE estimates the type of oil, number and size of spills. BOEMRE describes the rationale for these large and small oil-spill assumptions in the following subsections. The rationale for these large and small oil-spill assumptions is a mixture of project-specific information, modeling results, statistical analysis, and professional judgment.

The BOEMRE reviewed recent information available from oil spill analyses in the Arctic OCS Region. The major OSRA analyses include the Beaufort Sea Multiple-Sale Final EIS, the Sale 193 Final EIS, and the Arctic Multiple-Sale Draft EIS. For purposes of this evaluation BOEMRE uses the most recent small and large development oil spill analysis contained in Appendix A of the Arctic Multiple-Sale Draft EIS. The Arctic Multiple-Sale Appendix contains the most up to date information on environmental resources and the small and large oil spill estimates are not substantially different from those contained in the Beaufort Sea Multiple Sale and Sale 193 Final EIS.

Although, in each of the OSRA's estimates in the above documents, the statistical mean number of large spills is less than one over the life development and production in the Chukchi Sea and the Beaufort Sea, for purposes of analysis BOEMRE assumes one large spill occurs and then analyzes its effects in each of the areas. After BOEMRE analyzes the effects of a large oil spill, BOEMRE provides the chance of one or more large oil spills occurring over the production life of the project for the decisionmaker to consider in NEPA analyses. An analysis is done for small spills considering the number and volume of small spills. BOEMRE assumes small spills will occur over the exploration and development life of the proposed action. Most small spills occur into containment and never reach the environment.

1.0 ACCIDENTAL LARGE OIL SPILLS

To set a reference framework under which the analysis of large oil spills occurs, the following discussion provides the context for the sources of oil in the sea. The inputs of oil in the sea have declined through time to the present (USCG, 2011; Etkin, 2009). Possible causes for the decline include passage of the Oil Pollution Act of 1990 (OPA, 90), technology improvements, and implementation of safety-management systems that put into practice risk-reduction interventions. The exploration and production industry contributes approximately 2% of the annual input in North America (Figure A.1-1).

In 2003, the National Research Council (NRC) of the National Academy of Sciences completed *Oil in the Sea III*, its third examination of petroleum inputs into marine waters worldwide. Although direct comparisons between the 1975, 1985, and 2002 reports are difficult due to use of differing computational techniques, it is clear that petroleum inputs from other than natural sources have decreased significantly over 3 decades. Total petroleum input estimates decreased from 43 million barrels per year (MMbbl/yr) to 23 MMbbl/yr between the 1975 and 1985 reports, a 47% decrease. In the 2002 report, total petroleum inputs continued to decrease to 9 MMbbl/yr, a 61% decrease from the 1985 report estimate. Offshore oil and gas development is responsible for 4% of the petroleum in the world's marine environment. Offshore oil and gas petroleum development inputs per annum decreased from 0.56 MMbbl in the 1975 report to 0.35 MMbbl in the 1985 and 2002 reports. At the same time, annual offshore oil production increased from 2.3 billion barrels (Bbbl) to 4.6 Bbbl to 7.0 Bbbl between the three reporting periods. This demonstrates a significant reduction in petroleum inputs per billion barrels of production from worldwide offshore oil and gas development between the three reporting periods—from 243,000 bbl/Bbbl in the 1975 report to 76,000 bbl/Bbbl in the 1985 report to 50,000 bbl/Bbbl in the 2002 report—despite large increases in production. Therefore, even though worldwide production increased 52%, petroleum inputs were approximately the same (0.35 MMbbl per annum) between the 1985 and 2002 reports.

The 2003 report made estimates for North America. The four main categories were natural seeps, extraction of petroleum, transportation of petroleum, and consumption of petroleum. Offshore oil and gas development was responsible for 2% of the petroleum inputs in North America's marine environment. Natural seepage is the largest input, contributing 63% of total inputs to the marine environment. Consumption is the next largest input, contributing 32% of total inputs, 22% of which are land based and from river runoff. Marine transportation is responsible for 3% of inputs in North American marine waters (Figure A.1-1).

Between 1971 and 2007, Outer Continental Shelf (OCS) operators have produced almost 15 Bbbl of oil. During this period, there were 2,645 spills that totaled to approximately 164,100 bbl spilled (equal to 0.001% of barrels produced), or about 1 bbl spilled for every 91,400 bbl produced. This record has improved over time. Between 1993 and 2007, the most recent 15-year period, almost 7.5 Bbbl of oil were produced. During this period, there were 651 spills that totaled to approximately 47,800 bbl spilled (equal to 0.0006% of barrels produced), or approximately 1 bbl spilled for every 156,900 bbl produced (Anderson, 2008, pers. commun.).

1.1. Large Spill Size, Source, and Oil-Type Assumptions

The large spill size and source assumptions are the same for both Beaufort Sea and Chukchi Sea. Tables A.1-1 and A.1-2 show the general size categories, source of spill(s), type of oil, size of spill(s) in barrels, and the receiving environment BOEMRE assumes in our analysis of the effects of oil spills for the Proposed Action for the Beaufort and Chukchi seas, respectively. The sources of spills are divided generically into platform/rig or pipeline. Platform/rig includes spills from wells and tanks. The type of crude oil used in this analysis is Alaska North Slope crude for the Beaufort Sea and Alpine composite crude for the Chukchi Sea. In addition, BOEMRE looks at diesel fuel from tanks onboard a platform/rig and condensate from any possible gas production.

1.1.1. Large Oil-Spill Sizes

Large spills are $\geq 1,000$ bbl. Large spills have a threshold value of 1,000 bbl. This means 1,000 bbl is the minimum size in that category, and the size can be larger. Tables A.1-1 and A.1-2 show the assumed large spill sizes and the sections where BOEMRE analyzes the effects of large and small spill(s) for the Beaufort Sea and the Chukchi Sea, respectively.

The large spill-size assumptions BOEMRE uses are based on the reported spills from production in the Gulf of Mexico and Pacific OCS. BOEMRE uses the median spill size in the OCS from 1985-1999 as the likely large spill size. BOEMRE uses Gulf of Mexico and Pacific OCS spill sizes because no large spills have occurred on the Alaska OCS from oil and gas activities. Small spills are based on the historic spill sizes from production on the onshore Alaska North Slope from 1989-2000. Stakeholders, including the North Slope Borough Science Advisory Committee, have suggested using spill rates from the Alaska North Slope in Arctic OCS Regions. The assumption is that Alaska North Slope spills occur in more similar environments to the offshore Beaufort and Chukchi seas than the Gulf of Mexico and Pacific OCS.

1.1.2. Source and Type of Large Oil Spills

The source of large oil spills is generalized into two categories: production platforms and pipelines. The source is considered the place from which large oil spills could originate. Large production platform spills include spills from wells in addition to any storage tanks located on the platform. Large pipeline spills include spills from the riser and offshore pipeline to the shore. Large platform spills are assumed to be crude oil, condensate oil, or diesel oil from storage tanks. Large pipeline spills are assumed to be crude or condensate oil.

It is known that crude oils vary in properties and that crude oil spills behave in different ways based on their properties. Both of the crude oils considered in this analysis are medium crudes. The crude oils in the Chukchi Sea are estimated to be lighter than crude oil in the Beaufort Sea, given the existing information. Crude oil samples recovered from wells onshore Alaska North Slope and offshore Beaufort Sea are characterized by a range of American Petroleum Institute (API) gravity. BOEMRE uses Alaska North Slope crude as a composite oil for the Beaufort Sea. Alaska North Slope crude has an API gravity of 27-30°, depending on where and when it was sampled and chosen to be representative for oil-weathering simulations.

From crude oil samples recovered from wells, the Chukchi Sea oil seems to be characterized by relatively low sulfur (<18%), high-gravity ($\geq 35^\circ$) API crude oils (Sherwood et al., 1998:129). BOEMRE looked for Alaska North Slope crude oils with similar API gravity values and that had laboratory weathering data. Alpine composite crude oil has an API gravity of 35° and was chosen to be representative for the oil-weathering simulations.

For both Beaufort Sea and Chukchi Sea, BOEMRE chose a standard diesel oil and a condensate with an API gravity of 50° for the oil-weathering simulations.

1.1.3. Historical Crude Oil Spills $\geq 1,000$ bbl on the OCS

The Gulf of Mexico and Pacific OCS data show that a large spill most likely would be from a pipeline or a platform. Platform spills include spills from wells and tanks on the facility. The median size of a crude oil spill $\geq 1,000$ bbl from a pipeline from 1985-1999 on the OCS is 4,600 bbl, and the average is 6,700 bbl (Anderson and LaBelle, 2000). The median spill size for a platform on the OCS over the entire record from 1964-1999, based on trend analysis, is 1,500 bbl, and the average is 3,300 bbl (Anderson and LaBelle, 2000). For purposes of analysis, BOEMRE uses the median spill size as the likely large spill size.

1.1.4. Historical Crude and Condensate Oil Spills from Well-Control Incidents on the OCS and Alaska North Slope

This section updates information in the Sales 186, 195, 202 and 193 FEIS's Appendix A which discussed OCS well control incidents from 1971-2000 and 2005, respectively (Table A-3). The year 1971 is considered reflective of the modern regulatory environment. The term loss of well control was first defined in the 2006 update to the incident reporting regulations (30 CFR 250.188). Prior to this 2006 update, the incident reporting regulations included the requirement to report all blowouts, and the term blowout was undefined. Three relevant data sets are considered: (1) all well control incidents from 1971-2009 prior to the Deepwater Horizon incident to update the Beaufort Multisale and Chukchi Sale 193 FEIS information baseline, then (2) well control incident rates from exploration and development drilling including the Deepwater Horizon and finally (3) spills associated with well control incidents from exploration drilling including the Deepwater Horizon (USDOJ, BOEMRE, AIB, 2011).

OCS Exploratory and Development/Production Operations From 1971-2009: There were 249 well control incidents during exploratory and development /production operations on the OCS (this includes incidents associated with exploratory and development drilling, completion, workover, plug and abandon, and production operations). During this period, 41,514 wells were drilled on the OCS and 15.978 billion barrels (Bbbl) of oil was produced. Of the 249 well control incidents that occurred during this period, 50 resulted in the spillage of condensate/crude oil ranging from <1 bbl to 450 bbls. The total spilled from these 50 incidents was 1,829 bbls. This volume spilled was approximately 0.00001147% of the volume produced during this period.

In 2010, four well control incidents occurred, including the Deepwater Horizon event. Although a final spillage volume from the Deepwater Horizon incident has not been determined by BOEMRE, the current estimate from McNutt et al. (2011) is 4.9 million bbls. The three other well control incidents that occurred in 2010 did not result in the spillage of condensate or crude oil.

OCS Development and Exploration Well Drilling From 1971-2010: There were a total of 41,781 wells drilled in the OCS comprising of 40,565 wells in the Gulf of Mexico, 1,086 wells in the Pacific Region, 46 wells in the Atlantic Region and 84 wells in the Alaska Region. Of these, 26,245 were development wells, 15,491 were exploration wells and 43 were core tests or relief wells. The overall drilling well control incident rate is 1 well control incident per 292 wells drilled, compared to 1 well control incident per 410 development wells drilled, and 1 well control incident per 201 exploration wells drilled. These well control incident rates include all well control incidents related to drilling operations whether they spilled oil or not.

OCS Exploration Well Drilling From 1971-2010: Industry has drilled 223 exploration wells in the Pacific OCS, 46 in the Atlantic OCS, 15,138 in the Gulf of Mexico OCS, and 84 in the Alaska OCS, for a total of 15,491 exploration wells. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 resulted in oil spills ranging from 0.5 bbl to 200 bbls, for a total 354 bbls, excluding the estimated volume from the Deepwater Horizon incident. From 1971-2010 one well control incident resulted in a spill volume of 1,000 bbls or more and that was the Deepwater Horizon event.

Alaska North Slope: The blowout record for the Alaska North Slope remains the same as previously reported in USDOJ, MMS (2003) and is summarized herein. Of the 10 blowouts, 9 were gas and 1

was oil. The oil blowout in 1950 resulted from drilling practices that are not relevant today. A third study confirmed that no crude oil spills ≥ 100 bbl from blowouts occurred from 1985-1999 (Hart Crowser, Inc., 2000). Scandpower (2001) used statistical blowout frequencies modified to reflect specific field conditions and operative systems at Northstar. This report concludes that the blowout frequency for drilling the oil-bearing zone is 1.5×10^{-5} per well drilled. This compares to a statistical blowout frequency of 7.4×10^{-5} per well (for an average development well). This same report estimates that the frequency of oil quantities per well drilled for Northstar for a spill $>130,000$ bbl is 9.4×10^{-7} per well.

1.1.5. Historical Exploration Spills on the Beaufort and Chukchi OCS

The BOEMRE estimates the chance of a large ($\geq 1,000$ bbl) oil spill from exploratory activities to be very low. On the Beaufort and Chukchi OCS, the oil industry drilled 35 exploratory wells. During the time of this drilling, industry has had 35 small spills totaling 26.7 bbl or 1,120 gallons (gal). Of the 26.7 bbl spilled, approximately 24 bbl were recovered or cleaned up. Table A.1-4 shows the exploration spills on the Beaufort and Chukchi OCS. Small (50 bbl or less) operational or fuel transfer spills of diesel, refined fuel, or crude oil may occur. The BOEMRE estimates this could be a typical scenario during exploratory drilling in the Beaufort and Chukchi seas. These small spills often are onto containment on platforms, facilities, or gravel islands or onto ice and may be cleaned up.

1.1.6. Historical Exploration Well-Control Incidents

No exploratory drilling well-control incidents have occurred on the Alaskan OCS. One exploration drilling blowout of gas has occurred on the Canadian Beaufort Sea. Up to 1990, 85 exploratory wells were drilled in the Canadian Beaufort Sea, and one shallow-gas blowout occurred. A second incident was not included at the Amaluligak wellsite with the Molikpaq drill platform. This resulted in a gas flow through the diverter, with some leakage around the flange. The incident does not qualify as a blowout by the definition used in other databases and, therefore, was excluded (Devon Canada Corporation, 2004).

Industry has drilled 223 exploration wells in the Pacific OCS, 46 in the Atlantic OCS, 15,138 in the Gulf of Mexico OCS, and 84 in the Alaska OCS, for a total of 15,491 exploration wells. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 resulted in oil spills ranging from 0.5 bbl to 200 bbls, for a total 354 bbls, excluding the estimated volume from the Deepwater Horizon incident. From 1971-2010 one well control incident resulted in a spill volume of 1,000 bbls or more and that was the Deepwater Horizon event. (Table A.1-3, USDO, BOEMRE, AIB, 2011). It is recognized that the frequency for a very large oil spill (VLOS) on the OCS from a well control incident is very low. From 1971-2010 there has been one large/very large oil spill during exploratory and development/production operations on 41,781 OCS wells, or 2.39×10^{-5} per well.

2.0 BEHAVIOR AND FATE OF CRUDE OILS

There are scientific laboratory data and field information from accidental and research oil spills about the behavior and fate of crude oils. BOEMRE discusses the background information on the fate and behavior of oil in arctic environments and its behavior and persistence properties along various types of shorelines. BOEMRE also makes several assumptions about oil weathering to perform modeling simulations of oil weathering specific to the size spills BOEMRE estimates for analysis purposes.

2.1. Generalized Processes Affecting the Fate and Behavior of Oil

Several processes alter the chemical and physical characteristics and toxicity of spilled oil. Collectively, these processes are referred to as weathering or aging of the oil and, along with the physical oceanography and meteorology, the weathering processes determine the oil's fate. The major oil-weathering processes are spreading, evaporation, dispersion, dissolution, emulsification, microbial

degradation, photochemical oxidation, and sedimentation to the seafloor or stranding on the shoreline (Payne et al., 1987; Boehm, 1987; Lehr, 2001) (Figure A.1-2).

The physical properties of a crude, diesel, or condensate oil spill; the environment it occurs in; and the source and rate of the spill will affect how an oil spill behaves and weathers (Boehm and Page, 2007). The environment in which a spill occurs, such as the water surface or subsurface, spring ice overflow, summer open-water, winter under ice, winter on ice, or winter broken ice, will affect how the spill behaves. In ice-covered waters, many of the same weathering processes are in effect; however, the sea ice and cold temperatures change the rates and relative importance of these processes (Payne, McNabb, and Clayton, 1991).

After a spill occurs, spreading and advection begin. The slick spreads horizontally in an elongated pattern oriented in the direction of wind, waves and currents and nonuniformly into thin sheens (0.5-10 micrometers [μm]) and thick patches (0.1-10 millimeters [mm]) (Elliott, 1986; Elliott, Hurford, and Penn, 1986; Galt et al., 1991). In the cooler arctic waters, oil spills spread less and remain thicker than in temperate waters because of differences in the viscosity of oil due to temperature. This property will reduce spreading. An oil spill in broken ice would spread less and would spread between icefloes into any gaps greater than about 8-15 centimeters (cm) (3-6 inches [in]) (Free, Cox, and Shultz, 1982).

The presence of broken ice tends to slow the rate of spreading (S.L. Ross Environmental Research Ltd. and D.F. Dickens Assocs. Ltd., 1987). Oil spreading and floe motion were studied to determine how floe motion, ice concentration, slush concentration, and oil types affect spreading in ice. Spreading rates were lowered as ice concentrations increased; but for ice concentrations <20-30%, there was very little effect. Slush ice rapidly decreased spreading. If the ice-cover motion increased, then spreading rates increased, especially with slush ice present (Gjøsteen and Løset, 2004). Oil spilled beneath a wind-agitated field of pancake ice would be pumped up onto the surface of the ice or, if currents are slow enough, bound up in or below the ice (Payne et al., 1987). Once oil is encapsulated in pack ice, it has the potential to move distances from the spill site with the moving ice.

During deep winter the oil would freeze into the forming and existing ice sheets (Dickens, 2011; Mar, Inc. et al., 2008). Then, in late spring and summer, the unweathered oil would melt out of the ice at different rates, depending on whether it is encapsulated in multiyear or first-year ice, and depending on when the oil was frozen into the ice. In first-year ice, most (85%) of the oil spilled at any one time would percolate up to the ice surface over about a 10-day period (Dickens, Buist and Pistruzak, 1981; Mar Inc. et al., 2008; NORCOR, 1975; Nelson and Allen, 1981). In approximately mid-July, the oil pools would drain into the water among the floes of the opening ice pack. Thus, in first-year ice, oil would be pooled on the ice surface for up to 30 days before being discharged from the ice surface to the water surface. The pools on the ice surface would concentrate the oil, but only to about 2 centimeters thick, allowing evaporation of 5% of the oil, the part of the oil composed of the lighter, more toxic components. By the time the oil is released from the melt pools on the ice surface, evaporation will have almost stopped, with only an additional 4% of the spilled oil evaporating during an additional 30 days on the water.

Evaporation results in a preferential loss of the lighter, more volatile hydrocarbons, increasing density and viscosity and reducing vapor pressure and toxicity (Mackay, 1985). Evaporation of volatile components accounts for 30-40% of crude loss, with approximately 25% occurring in the first 24 hours (Fingas, Duval, and Stevenson, 1979; National Research Council, 1985). The initial evaporation rate increases with increasing wind speeds, temperatures, and sea state. Evaporative processes occur on spills in ice-covered waters, although at a lower rate (Jordan and Payne, 1980). Fuel oils (diesel) evaporate more rapidly than crude, on the order of 13% within 40 hours at 23 °Celsius (73 °Fahrenheit); a larger overall percentage of diesel eventually will evaporate. Evaporation decreases in the presence of broken ice and stops if the oil is under or encapsulated in the ice (Payne et al., 1987). The lower the temperature, the less crude oil evaporates. Both Prudhoe Bay and Endicott crudes have experimentally followed this pattern (Fingas, 1996). Oil between or on icefloes is subject to normal evaporation. Oil that is frozen into the underside of ice is unlikely to undergo any

evaporation until its release in spring. In spring, as the ice sheet deteriorates, the encapsulated oil will rise to the surface through brine channels in the ice. As oil is released to the surface, evaporation will occur.

Dispersion of oil spills occurs from wind, waves, currents, or ice. Dispersion is an important breakup process that results in the transport of small oil particles (0.5 μm -several mm) or oil-in-water emulsions into the water column (Jordan and Payne, 1980; National Research Council, 1985). Droplets <0.5 mm or less rise slowly enough to remain dispersed in the water column (Payne and McNabb, 1985). The dispersion rate is directly influenced by sea state; the higher the sea state and breaking waves, the more rapid the dispersion rate (Mackay, 1985). The presence of broken ice promotes dispersion (Payne et al., 1987). Any waves within the ice pack tend to pump oil onto the ice. Some additional oil dispersion occurs in dense, broken ice through floe-grinding action. More viscous and/or weathered crudes may adhere to porous icefloes, essentially concentrating oil within the floe field and limiting the oil dispersion.

Dissolution results in the loss of soluble, low-molecular-weight aromatics such as benzene, toluene, and xylenes (National Research Council, 1985). Low-molecular weight aromatics, which are acutely toxic, rapidly dissolve into the water column. Dissolution, however, is very slow compared with evaporation; most volatiles usually evaporate rather than dissolve. Dissolved-hydrocarbon concentrations underneath a slick, therefore, tend to remain <1 part per million (Malins and Hodgins, 1981). Dissolved-hydrocarbon concentration can increase due to the promotion of dispersion by broken ice (Payne et al., 1987). Faksness and Brandvik (2008a) studied the dissolved water-soluble components encapsulated in first-year sea ice. Their data show a concentration gradient from the surface of the ice to the bottom, indicating there is transport of the dissolved components through brine channels. Field studies also showed that high air temperature leads to more porous ice, and the dissolved water-soluble components leak out rapidly but, under cold air temperatures and less porous ice, the water-soluble components leak more slowly and have potentially toxic concentrations (Faksness and Brandvik, 2008b).

Emulsified oil results from oil incorporating water droplets in the oil phase and generally is referred to as mousse (Mackay, 1982). The measurable increases in viscosity and specific gravity observed for mousse change its behavior, including spreading, dispersion, evaporation, and dissolution (Payne and Jordan, 1985). The formation of mousse slows the subsequent weathering of oil. The presence of slush ice and turbulence promotes oil-in-water emulsions (Payne et al., 1987).

Most of the oil droplets suspended in the water column eventually will be degraded by bacteria in the water column or deposited on the seafloor. The rate of sedimentation depends on the suspended load of the water, the water depth, turbulence, oil density, and incorporation into zooplankton fecal pellets.

Subsurface blowouts or gathering-pipeline spills disperse small oil droplets and entrained gas into the water column. With sufficient gas, turbulence, and the necessary precursors in the oils, mousse forms by the time the oil reaches the surface (Payne, 1982; Thomas and McDonagh, 1991). For subsurface spills, oil rises rapidly to the water surface to form a slick. Droplets <50 microns in size, generally 1% of the blowout volume, could be carried several kilometers downcurrent before reaching the water surface (Environmental Sciences Limited, 1982). Blowout simulations show that convective cells set up by the rising oil and gas plume result in concentric rings of waves around the central plume. Surface currents within the ring should move outward, and surface currents outside the ring should move inward, resulting in a natural containment of some oil.

The subsurface release of oil droplets increases slightly the dissolution of oil, but the rapid rise of most oil to the surface suggests that the increase in dissolution—as a percentage of total spill volume—is fairly small. The resulting oil concentration, however, could be substantial, particularly for dispersed oil in subsurface plumes.

An oil spill that occurred under or moved under landfast ice would follow this sequence:

1. The oil will rise to the under-ice surface and spread laterally, accumulating in the under-ice cavities (Glaeser and Vance, 1971; NORCOR, 1975; Martin, 1979; Comfort et al., 1983).

2. For spills that occur when the ice sheet is still growing, the pooled oil will be encapsulated in the growing ice sheet (NORCOR, 1975; Keevil and Ramseier, 1975; Buist and Dickens, 1983; Comfort et al., 1983). In spring, as the ice begins to deteriorate, the encapsulated oil will rise to the surface through brine channels in the ice (NORCOR, 1975; Purves, 1978; Martin, 1979; Kisil, 1981; Dickins and Buist, 1981; Comfort et al., 1983).

The spread of oil under the landfast ice may be affected by many factors, including the viscosity of the oil, the under-ice topography, and currents. The under-ice topography will greatly influence the oil-pooling capacity. Studies of spreading under a landfast ice sheet have yielded different amounts of oil capacity (Kovacs, 1977; Kovacs et al., 1981). Wilkinson, Wadhams and Hughes (2007) discuss the ability to measure under-ice topography with upward looking multibeam sonar mounted on an AUV to better estimate holding capacity at a particular location. They hypothesize that previous oil-pooling capacity was overestimated and, hence, the spreading rates are underestimated.

The spread of oil offshore will be influenced by the presence of currents, if the magnitude of those currents is large enough. A field study near Cape Parry in the Northwest Territories reported that currents up to 10 cm per second (cm/sec) were present. This current was insufficient to strip oil from under the ice sheet after the oil had ceased to spread (NORCOR, 1975). Laboratory tests have shown that currents in excess of 15-25 cm/sec are required to strip oil from under-ice depressions (Cammaert, 1980; Cox et al., 1980). Current speeds in the nearshore Beaufort generally are <10 cm/sec during winter (Weingartner et al., 2009). The area of contamination for oil under ice could increase if the ice were to move. Because the nearshore Beaufort and the very nearshore Chukchi is in the landfast ice area, the spread of oil due to ice movement would not be anticipated until spring breakup. Lately, breakout events of landfast ice have occurred prior to spring breakup. Spills onshore can be affected by the ice content. Pore ice can increase lateral movement, create preferential flow paths allowing deeper penetration, or restrict infiltration due to high ice saturation in the surface soil (Barnes and Wolfe, 2008).

Prince et al. (2003) discuss three northern spills and demonstrate that photo-oxidation and biodegradation play an important role in the long-term weathering of crude oils even in cold temperatures. Photo-oxidation and biodegradation would continue to weather the oil remaining. In addition to sunlight breaking down the oil, sunlight has the potential for photo-enhanced toxicity (Barron et al., 2008).

Alpine composite and Alaska North Slope crude oil will emulsify readily to form stable emulsions. Emulsification of some crude oils is increased in the presence of ice. With floe grinding, it is likely that Alpine and Alaska North Slope crude may form mousse within a few hours, an order of magnitude more rapidly than in open water.

2.2. Oil-Spill Persistence

How long an oil spill persists on water or on the shoreline can vary, depending on the size of the oil spill, the environmental conditions at the time of the spill, and the substrate of the shoreline and, in the case of the Arctic, whether the shoreline is eroding. Persistence on water and then on shorelines is discussed below.

2.2.1. On-Water Oil-Spill Persistence

S.L. Ross et al. (2003) studied the persistence of oil spilled on the surface of the water. For purposes of the study, an oil slick persisted on the sea surface if it was observed to be a coherent slick or perceptible segments of a coherent slick, by normal methods of slick detection, such as aerial surveillance. After worldwide spills were reviewed, 32 spills had enough good persistence data. Refinement of quantitative estimates of oil-slick persistence will depend on collecting further information on spills and their lifetime as slicks on the water. Currently, this information is not routinely collected during oil-spill response. This limits the ability to make estimates about the persistence of large oil spills on the water as a coherent slick. In this analysis, BOEMRE

conservatively assumes a 1,500- and 4,600-bbl spill could last up to 30 days on the water as a coherent slick.

2.2.2. Shoreline Type, Behavior, and Persistence

The shoreline habitats and the estimation of the behavior and persistence of oil on intertidal habitats is based on an understanding of the dynamics of the coastal environments, not just the substrate type and grain size. The sensitivity of a particular intertidal habitat is an integration of the following factors: (1) shoreline type (substrate, grain size, tidal elevation, origin); (2) exposure to wave and tidal energy; (3) biological productivity and sensitivity; and (4) ease of cleanup. All of these factors are used to determine the relative sensitivity of intertidal habitats. Key to the sensitivity ranking is an understanding of the relationships between physical processes, substrate, shoreline type, product type, fate and effect, and sediment-transport patterns. The intensity of energy expended on a shoreline by wave action, tidal currents, and river currents directly affects the persistence of stranded oil. The need for shoreline-cleanup activities is determined, in part, by the slowness of natural processes in removal of oil stranded on the shoreline. These concepts have been used in the development of the Environmental Sensitivity Index (ESI) for shorelines, which ranks shoreline environments as to their relative sensitivity to oil spills, potential biological injury, and ease of cleanup. Generally speaking, areas exposed to high levels of physical energy, such as wave action and tidal currents, and low biological activity rank low on the scale, whereas sheltered areas with associated high biological activity rank highest. A comprehensive shoreline habitat-ranking system has been developed for the entire United States. The shoreline habitats delineated on the Northwest Alaska and North Slope of Alaska are listed in order of increasing sensitivity to spilled oil: 1A) Exposed Rocky Shore; 1B) Exposed Solid Manmade Structure; 3A) Fine- to Medium-Grained Sand Beaches; 3C) Tundra Cliffs; 4) Coarse-Grained Sand Beaches; 5) Mixed Sand and Gravel Beaches; 6A) Gravel Beaches; 7) Exposed Tidal Flats; 8A) Sheltered Rocky Shores and Sheltered Scarps in Bedrock, Mud, or Clay; 8B) Sheltered, Solid Manmade Structures; 8E) Peat Shorelines; 9A) Sheltered Tidal Flats; 9B) Sheltered Vegetated Low Banks; 10A) Salt- and Brackish-Water Marshes; 10E) Inundated Low-Lying Tundra; and U) Unranked (USDOD, NOAA, 2002; Research Planning Institute, 2002).

The ESI rankings progress from low to high susceptibility to oil spills. In many cases, the shorelines also are ranked with multiple codes such as 10E/7. The first number is the most landward shoreline type, saltmarsh, with exposed tidal flats being the shoreline type closest to the water. For purposes of analysis, BOEMRE uses the shoreline type closest to the water. Table A.1-5 shows the percentage length of each ESI ranking for the most seaward shoreline type for each land segment in United States, Alaska waters. No ESI data are available for Russia.

The percentage length of each ESI type was derived by determining the length of coastline for each land segment. The length of each ESI type was determined for that land segment and then calculated as a percentage of the total land segment length.

2.2.3. Oil-Spill Toxicity

Oil-spill toxicity is discussed in the effects of spills on each resource in their respective sections.

2.3. Assumptions about Large Oil-Spill Weathering

To run the weathering models using a consistent framework, several assumptions are made regarding the type of oil, the size of the spill, the environmental conditions, and the location of the spill. The following assumptions are used to estimate large oil-spill weathering:

- The crude oil properties will be similar to Alaska North Slope crude oil for the Beaufort Sea, and to Alpine composite crude oil for the Chukchi Sea;
- The condensate oil properties will be similar to a Sliepner condensate for the Beaufort Sea, and for the Chukchi Sea;
- The diesel oil properties will be similar to a typical diesel fuel for the Beaufort Sea and for the Chukchi Sea;

- The size of the diesel spill is 1,500 bbl.;
- The size of the crude or condensate spill is 1,500 or 4,600 bbl.;
- There is no reduction in the size of spill due to cleanup;
- The wind, wave, and temperature conditions are as described;
- The spill is a surface spill;
- Meltout spills occur into 50% ice cover;
- The properties predicted by the model are those of the thick part of the slick;
- The spill occurs as an instantaneous spill over a short period of time;
- The fate and behavior are as modeled (Tables A.1-6 through 12); and
- The oil spill persists for up to 30 days in open water.

Uncertainties about oil spills exist, such as:

- the actual size of a large oil spill or spills, should they occur;
- whether the spill is instantaneous or chronic;
- the location of the spill;
- wind, current, wave, and ice conditions at the time of a possible oil spill; and
- the crude, diesel or condensate oil properties at the time of a possible spill.

2.4. Modeling Simulations of Oil Weathering

To judge the effect of a large oil spill, BOEMRE estimates information regarding how much oil evaporates, how much oil is dispersed, and how much oil remains after a certain time period. BOEMRE derives the weathering estimates of Alaska North Slope crude oil, Alpine composite crude oil, and Slipepner-condensate and diesel fuel from modeling results from the SINTEF Oil Weathering Model (OWM) Version 3.0 (Reed et al., 2005a) for up to 30 days.

2.4.1. Oils for Analysis

The oils used in the analysis are medium crude oils. Alaska North Slope crude composite, with a range of 27-30° API, was chosen for oil weathering simulations for the Beaufort Sea. This API range is representative of known crudes in the offshore Beaufort Sea. Alpine oil composite was chosen for simulations of oil weathering for the Chukchi Sea, because it is a light crude oil that falls within the category of 35-40° API oils estimated to occur in the Chukchi Sea area. For both the Beaufort Sea and the Chukchi Sea, BOEMRE used a diesel fuel and Slipepner condensate.

2.4.2. Alaska North Slope, Alpine Composite, Condensate, and Diesel Fuel Simulations of Oil Weathering

BOEMRE uses the SINTEF OWM to perform simulations of oil weathering. The SINTEF OWM changes both oil properties and physical properties of the oil. The oil properties include density, viscosity, pour point, flash point, and water content. The physical processes include spreading, evaporation, oil-in-water dispersion, and water uptake. The SINTEF OWM Version 3.0 performs a 30-day time horizon on the model-weathering calculations, but with a warning that the model is not verified against experimental field data for more than 4-5 days. The SINTEF OWM has been tested with results from three full-scale field trials of experimental oil spills (Daling and Strom, 1999).

The SINTEF OWM does not incorporate the effects of the following:

- currents
- containment
- microbiological degradation
- encapsulation by ice
- beaching
- photo-oxidation
- adsorption to particles

The simulated Alaska North Slope composite and Alpine composite crude and the condensate oil-spill sizes are 1,500 bbl or 4,600 bbl. The diesel-oil-spill size is 1,500 bbl. BOEMRE simulates two

general scenarios: one in which the oil spills into open water and one in which the oil freezes into the ice and melts out into 50% ice cover.

The Beaufort and Chukchi seas generally are slightly different in terms of the timing of freezeup and meltout. For the Beaufort Sea, BOEMRE assumes open water is July through September, and a winter spill melts out in July. For the Chukchi Sea BOEMRE assumes open water is June through October, and a winter spill melts out in June. BOEMRE assumes the spill starts at the surface. For open water, BOEMRE models the weathering of the 1,500- or 4,600-bbl spills as if they are instantaneous spills. For the meltout spill scenario, BOEMRE models the entire spill volume as an instantaneous spill. Although different amounts of oil could melt out at different times, BOEMRE took the conservative approach, which was to assume all the oil was released at the same time. BOEMRE reports the results at the end of 1, 3, 10, and 30 days.

For purposes of analysis, BOEMRE considers the mass balance of the large oil spill; how much is evaporated, naturally dispersed, and remaining. Tables A.1-6 and A.1-7 summarize the results BOEMRE assumes for the amount evaporated, naturally dispersed, and remaining for Alaska North Slope composite crude oil; Table A.1-8 for a diesel fuel; Tables A.1-9 and 10 for condensate oil, and Tables A.1-11 and 12 for Alpine composite crude oil. This information is used in BOEMRE's analysis of the effects of oil on listed species and critical habitat.

In general, diesel fuel and condensates will evaporate and disperse in a short period of time (1-10 days). The higher the wind speeds, the more rapid the evaporation and dispersion. Crude oils tend to evaporate and disperse more slowly, especially if the oils become emulsified. The Alaska North Slope composite will evaporate more slowly than the Alpine composite, but less remains because it disperses more. Crude oil properties vary, and these are representative ranges of how different medium crudes may weather.

The Alaska North Slope composite contains a relatively large amount of lower molecular-weight compounds, and approximately 16% and 22% of its original volume evaporated within 1 and 3 days, respectively, at both summer and winter temperatures. At the average wind speeds over the Sales Beaufort Sea area, dispersion is slow, ranging from 2-16%. However, at higher wind speeds (e.g., 15 m/s wind speed) the slick will be almost removed from the sea surface within a day.

The Alpine composite contains a relatively large amount of lower molecular-weight compounds, and approximately 29% and 33% of its original volume evaporated within 1 and 3 days, respectively, at both summer and winter temperatures. Alpine composite will form water-in-oil-emulsion with a maximum water content of 80% at both winter and summer temperatures, yielding approximately five times the original spill volume (Reed et al. 2005b). At the average wind speeds over the Chukchi Sea area, dispersion is slow, ranging from 0-16%. However, at higher wind speeds (e.g., 15 m/s wind speed) the slick will be almost removed from the sea surface within a day.

3.0 ESTIMATES OF WHERE A LARGE OFFSHORE OIL SPILL MAY GO

BOEMRE studies how and where large offshore spills move by using a computer model called the Oil-Spill-Risk Analysis (OSRA) model (Smith et al., 1982). By large, BOEMRE means spills with a threshold size of $\geq 1,000$ bbl. This model analyzes the likely paths of over 2 million simulated oil spills in relation to biological, physical, and sociocultural resource areas that BOEMRE generically call environmental resource areas. The model uses information about the physical environment, including files of wind, sea ice, and current data. It also uses the locations of environmental resource areas, sociocultural resource areas, barrier islands, and the coast that are within the model study area.

3.1. Inputs to the Oil-Spill-Trajectory Model

There are several inputs necessary to run the oil-spill-trajectory model, including the following:

- study area;
- location of the coastline;
- arctic seasons;
- location of grouped land segments;

- location of land segments and seasonal land segments;
- location of boundary segments;
- location of hypothetical pipelines and transportation assumptions;
- location of environmental resource areas;
- wind information.
- location of hypothetical launch areas;
- current and ice information from two general circulation models; and

3.1.1. Study Area and Boundary Segments

Map A.1-1 shows the Beaufort and Chukchi Sea oil-spill-trajectory study area extends from lat. 68° N. to 75° N. and from long. 134° W. to 174° E. The study area is formed by 38 boundary segments and the Beaufort (United States and Canada) and Chukchi seas (United States and Russia) coastline. The boundary segments are vulnerable to spills in both arctic summer and winter. BOEMRE chose a study area large enough to mostly contain each of the paths of 2,700 hypothetical oil spills through as long as 360 days.

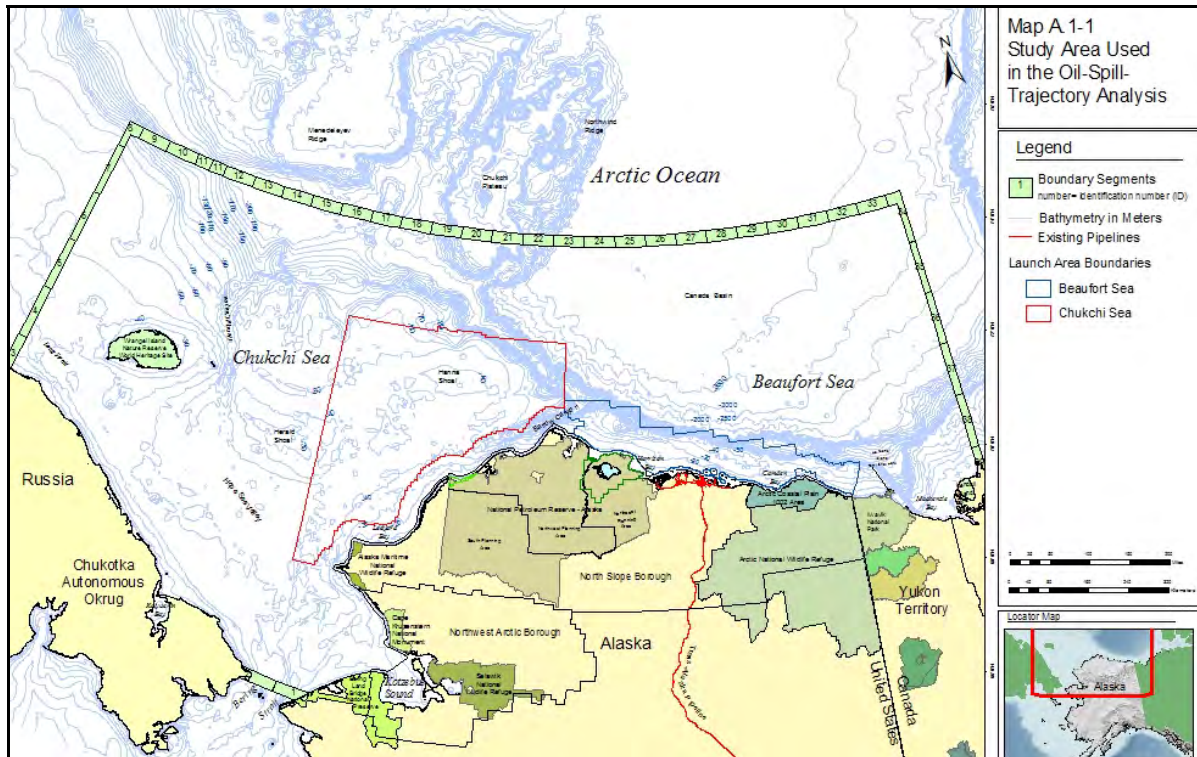


Figure 1 Map A. 1-1 Study Area Used in the Oil Spill Trajectory Analysis.

3.1.2. Trajectory Starting Periods

BOEMRE defines three time periods for the trajectory analysis of large oil spills. These periods are the months when trajectories are started and the chance of contact is tabulated. BOEMRE calls these three periods annual, summer, and winter. These periods have different months in the Beaufort Sea and the Chukchi Sea. Shown below are the three seasonal time periods that trajectories were started and the months that make them up.

Area	Annual	Summer	Winter
Beaufort Sea	January-December	July 1-September 30	October 1-June 30
Chukchi Sea	January-December	June 1-October 31	November 1-May 31

In the Beaufort Sea, the first period, called annual, is from January through December and represents the entire year. BOEMRE started 2,700 trajectories over the annual season. The second period is from July 1 through September 30 and generally represents open water or arctic summer. BOEMRE started

675 trajectories in the arctic summer. The third period is from October 1 through June 30 and represents ice cover or arctic winter. BOEMRE started 2,025 trajectories in the arctic winter.

In the Chukchi Sea, the first period, called annual, is from January through December and represents the entire year. BOEMRE started 2,700 trajectories over the annual season. The second period, called summer, is from June 1 through October 31 and generally represents open water or arctic summer. BOEMRE started 1,125 trajectories in the arctic summer. The third period, called winter, is from November 1 through May 31 and generally represents ice cover or arctic winter. BOEMRE started 1,575 trajectories in the arctic winter.

3.1.3. Locations of Environmental Resource Areas

Environmental resource areas (ERAs) represent areas of social, economic, or biological resources. Our analysts designate these ERAs. The analysts also designate in which months these ERAs are vulnerable to spills, meaning the time period those resources occupy that spatial location. For example, birds may migrate and may be there only from May to October.

Between the Beaufort Sea and the Chukchi Sea, the OSRA model includes 101 ERAs. Not all ERAs are used for the proposed action analysis. In the Beaufort Sea, there are 88 ERAs, with 93 ERAs in the Chukchi Sea. They are divided up into the Beaufort and Chukchi seas as follows: 80 are from both the Chukchi Sea and the Beaufort Sea; 8 are from the Beaufort Sea only, and 13 are from the Chukchi Sea only (Table A.1-13). Reserved Beaufort ERA identification numbers (IDs) (used in the Beaufort but not in the Chukchi) include ERA IDs 12, 20, 21, 22, 33, 34, 60, and 90. Reserved Chukchi ERA IDs (used in the Chukchi but not in the Beaufort) include ERA IDs 3, 4, 5, 13, 16, 53, 54, 57, 59, 61, 82, 83, and 91.

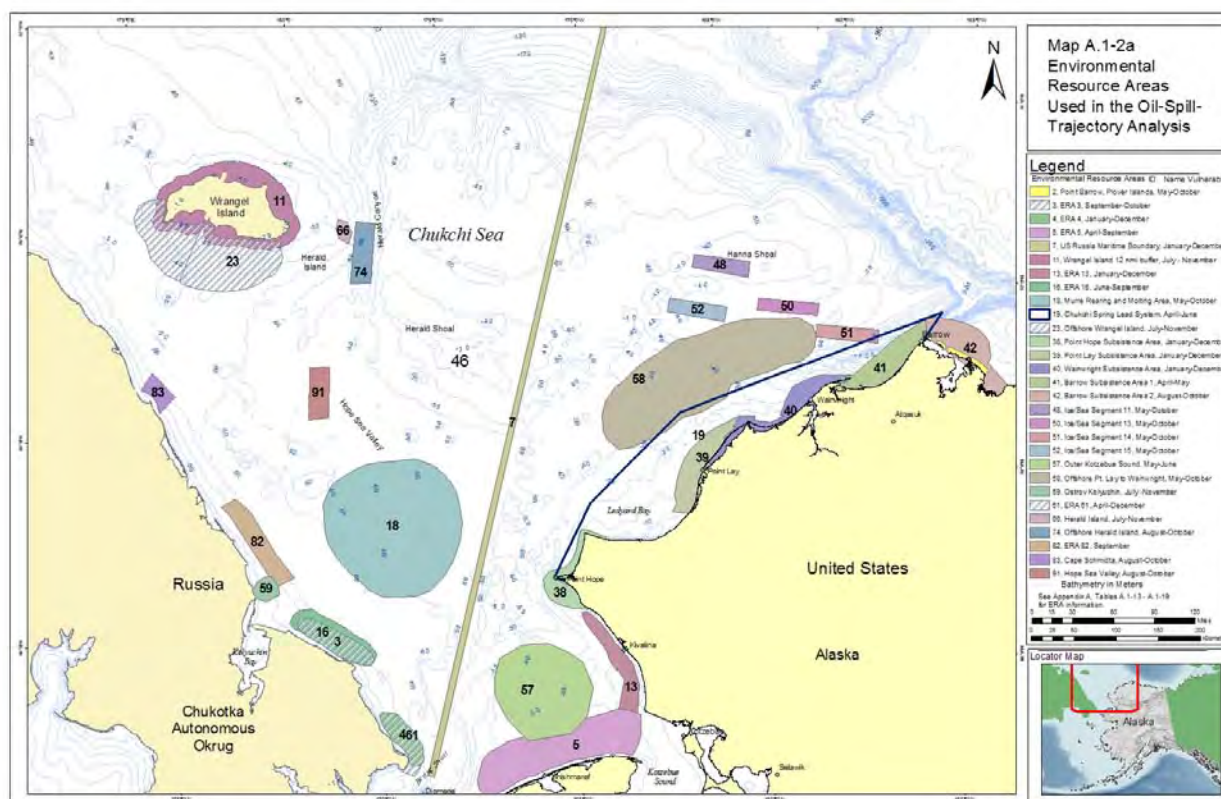


Figure 2 Map A.1-2a Environmental Resources Areas Used in Oil Spill Trajectory Analysis.

Maps A.1-2a, A.1-2b, A.1-2c, A.1-2d, and A.1.2e show the location of the 101 ERAs. These resource areas represent concentrations of wildlife, subsistence-hunting areas, and subsurface habitats. The names or abbreviations of the ERAs and the months in which they are vulnerable to spills are shown in Table A.1-13. Information regarding the general and specific ERAs for birds, whales, subsistence

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resources, marine mammals, fish, and lower trophic resources is found in Tables A.1-14, 15, 16, 17, 18, and 19, respectively. BOEMRE also include Land as an additional ERA. Land is the entire study area coastline and is made up of the individual land segments (LSs) 1 through 126, which are described below.

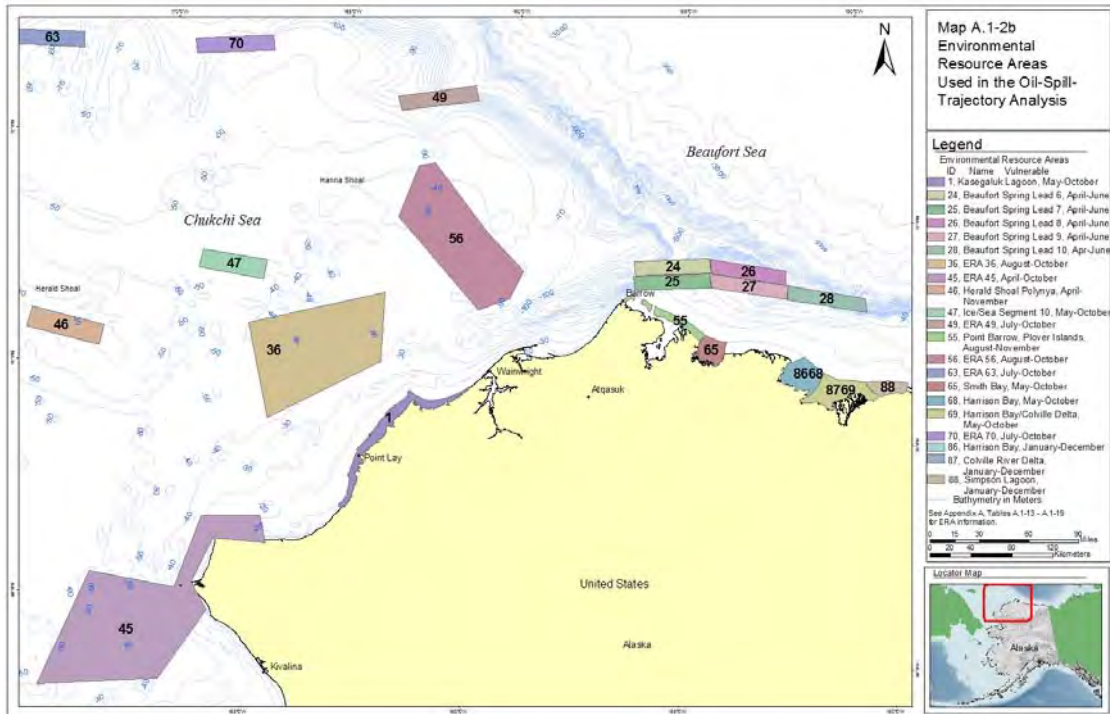


Figure 3 Map A. 1-2b Environmental Resources Areas Used in Oil Spill Trajectory Analysis.

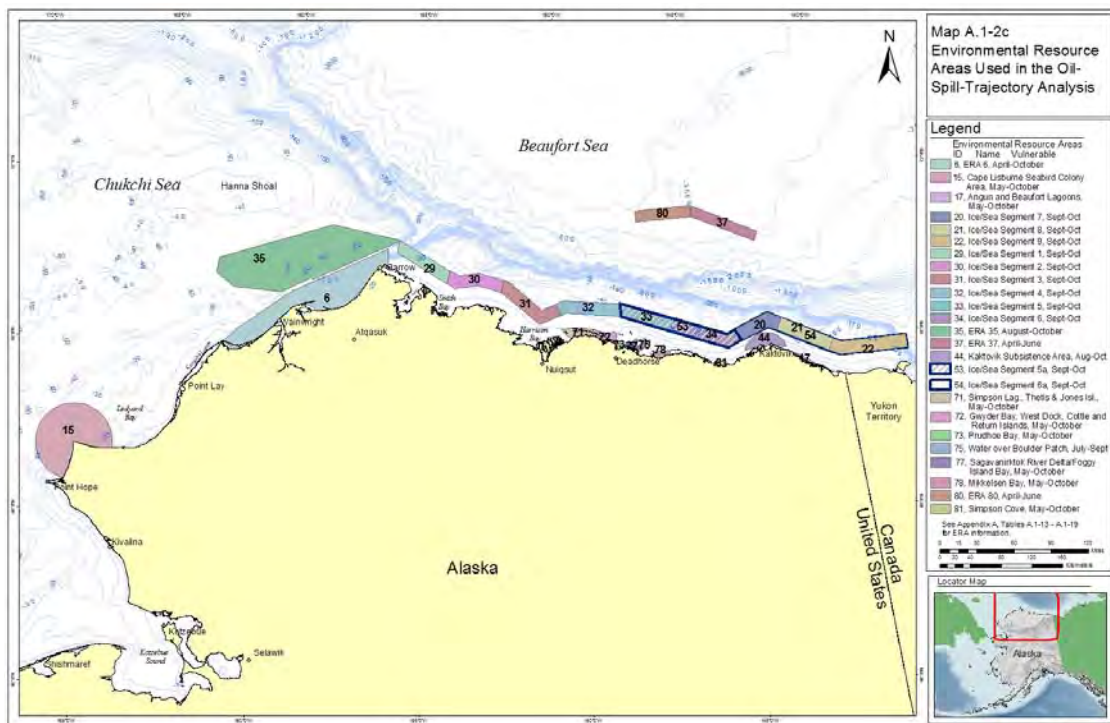


Figure 4 Map A. 1-2c Environmental Resources Areas Used in Oil Spill Trajectory Analysis.

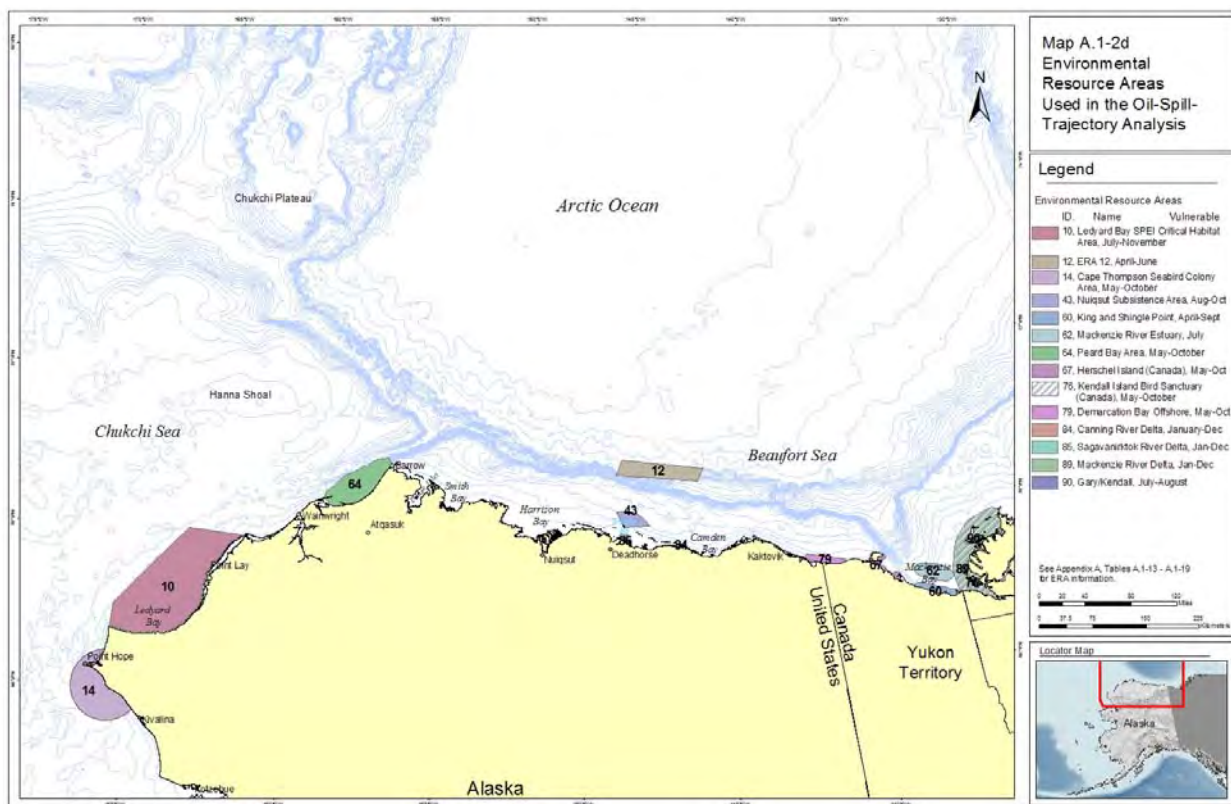


Figure 5 Map A. 1-2d Environmental Resources Areas Used in Oil Spill Trajectory Analysis.

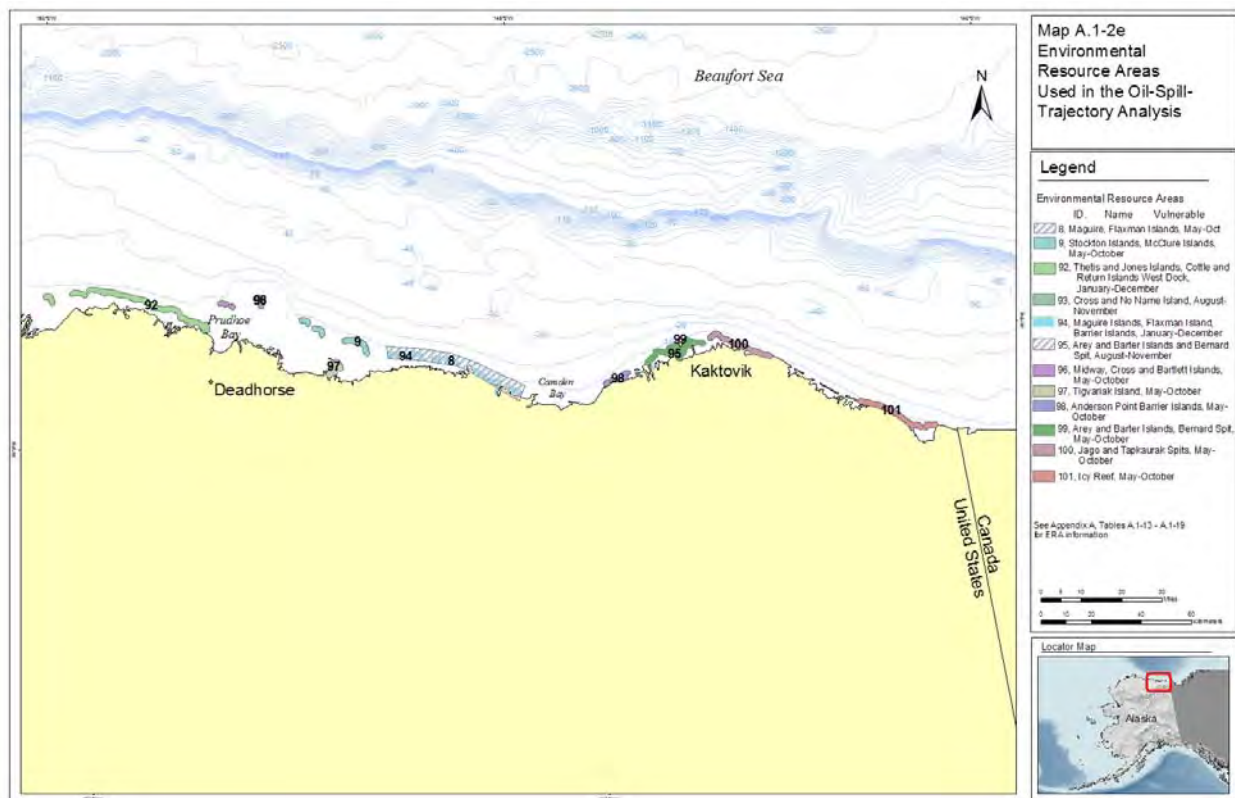


Figure 6 Map A. 1-2e Environmental Resources Areas Used in Oil Spill Trajectory Analysis.

3.1.4. Location of Land Segments, Seasonal Land Segments, and Grouped Land Segments

The coastline was further analyzed by dividing the Chukchi (United States and Russia) and Beaufort (United States and Canada) seas coastline into 126 Land Segments (LSs). Maps A.1-3a, A.1-3b, and A.1-3c show the location of these 126 LSs. Land segments were further analyzed in two ways. First, some LSs were set to different vulnerabilities and called seasonal land segments (SLSs). The SLSs have the same ID's but different vulnerabilities. Second, some LSs were added together to form larger geographic areas and called grouped land segments (GLSs).

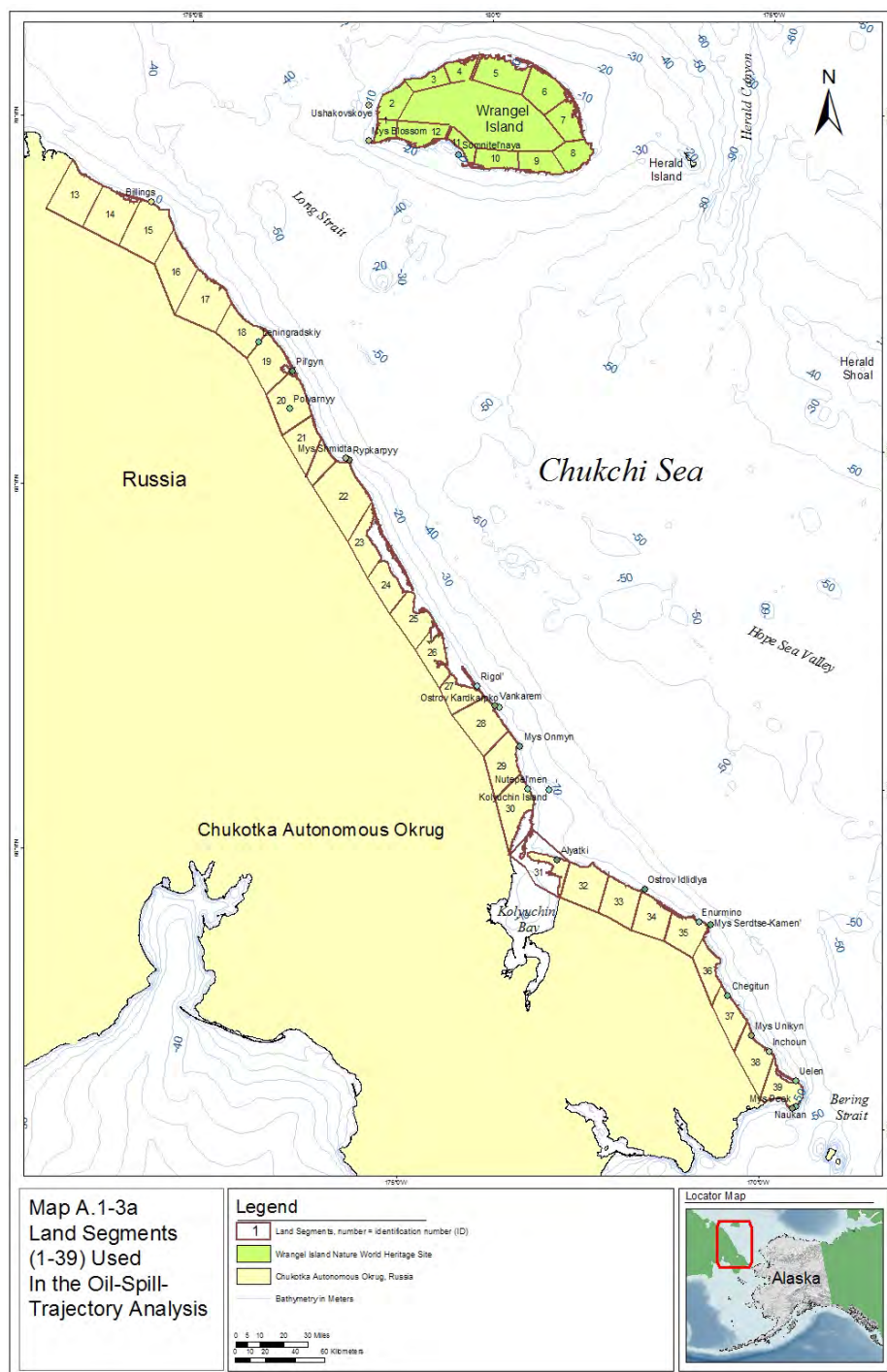


Figure 7 Map A. 1-3a Land Segments (1-39) Used in the Oil Spill Trajectory Analysis.

The LS IDs and the geographic place names within the LS are shown in Table A.1-20. Land segments are vulnerable to spills in both arctic summer and winter (Jan. through Dec.). For the Beaufort Sea, the model defines summer from July 1 through September 30 and winter as October 1 through June 30. In the Chukchi Sea, the model defines summer as June through October and winter from November through May.

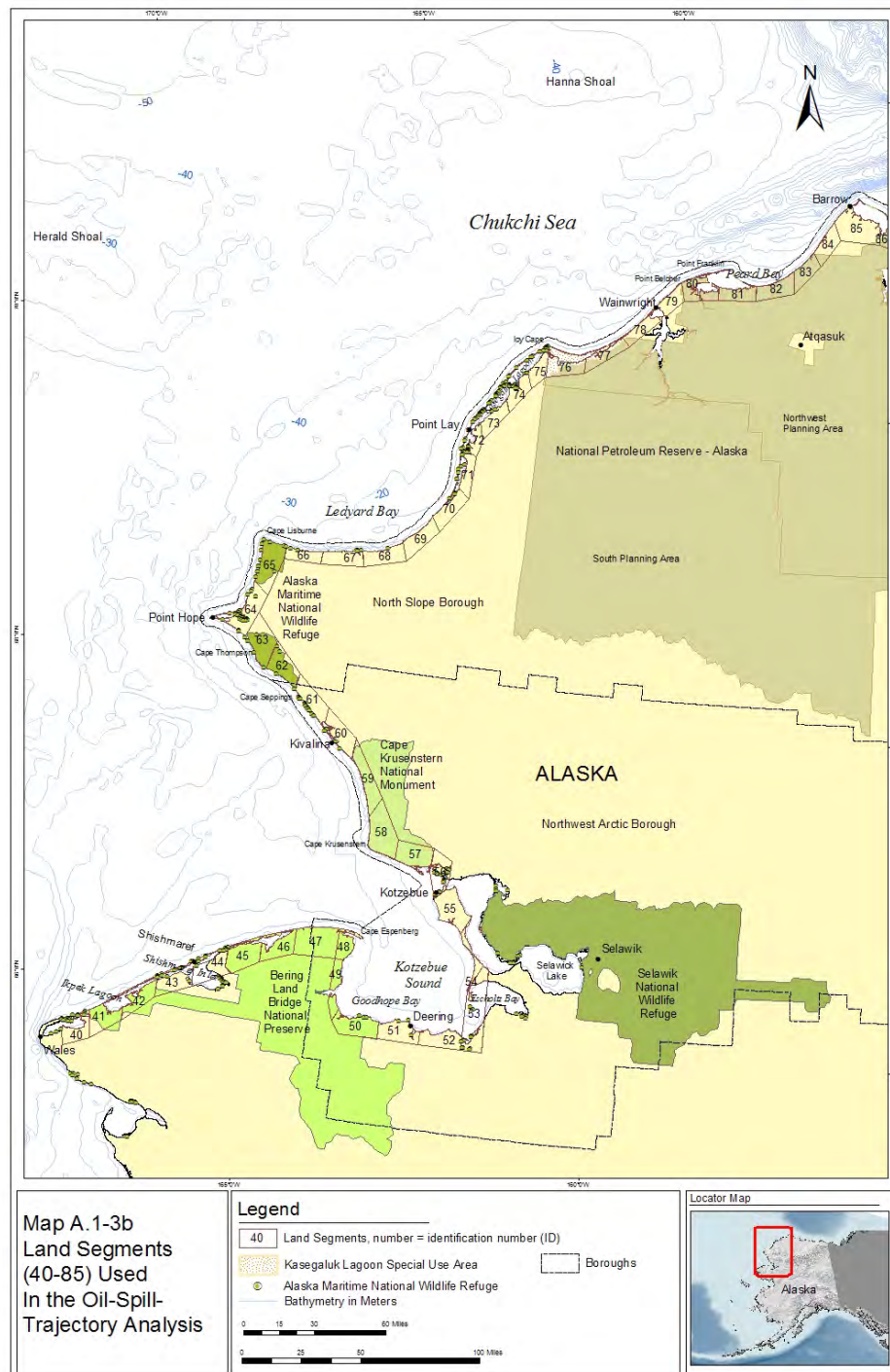


Figure 8 Map A. 1-3b Land Segments (40-85) Used in the Oil Spill Trajectory Analysis.

A set of SLs were set to different vulnerabilities than January through December to represent resources that are generally not there all year long. These SLs represent not just the chance of contacting land during the entire year, but the chance of contacting land when those resources are present. Only annual conditional probabilities were tabulated for SLs, as summer or winter

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conditional probabilities represent very similar time periods as the vulnerable period. Table A.1-21 shows the SLS ID, which is the same as the LS ID, the resources, and the vulnerable period.

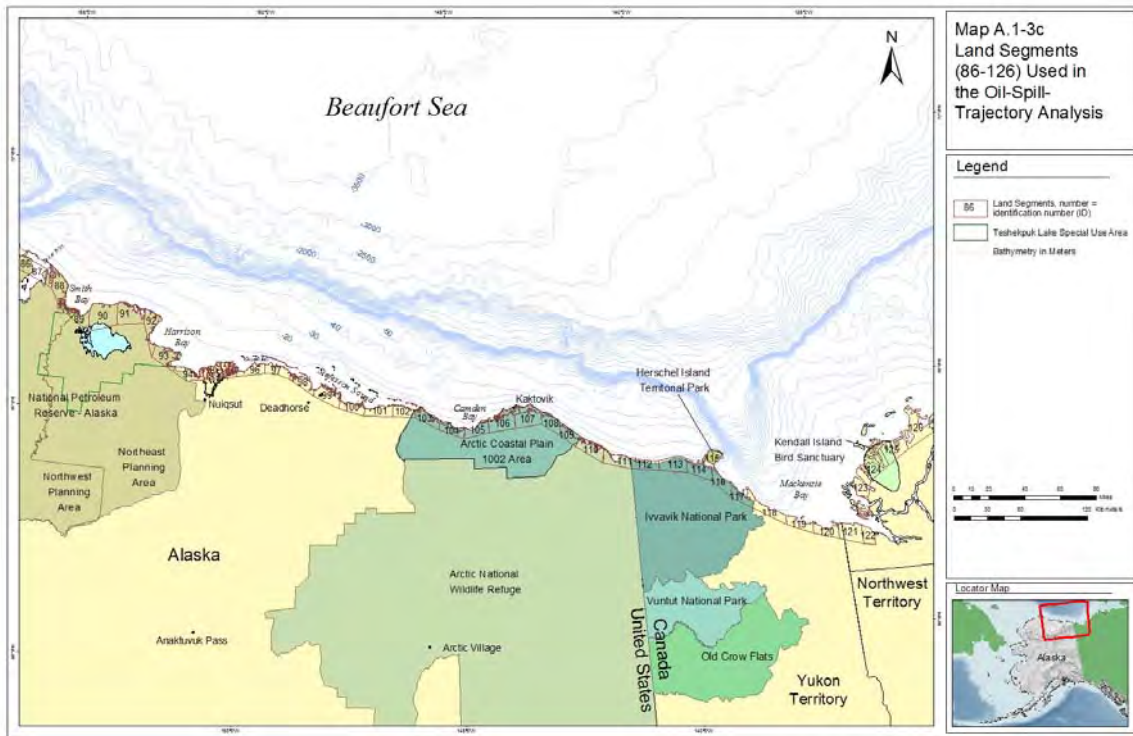


Figure 9 Map A. 1-3c Land Segments (86-126) Used in the Oil Spill Trajectory Analysis.

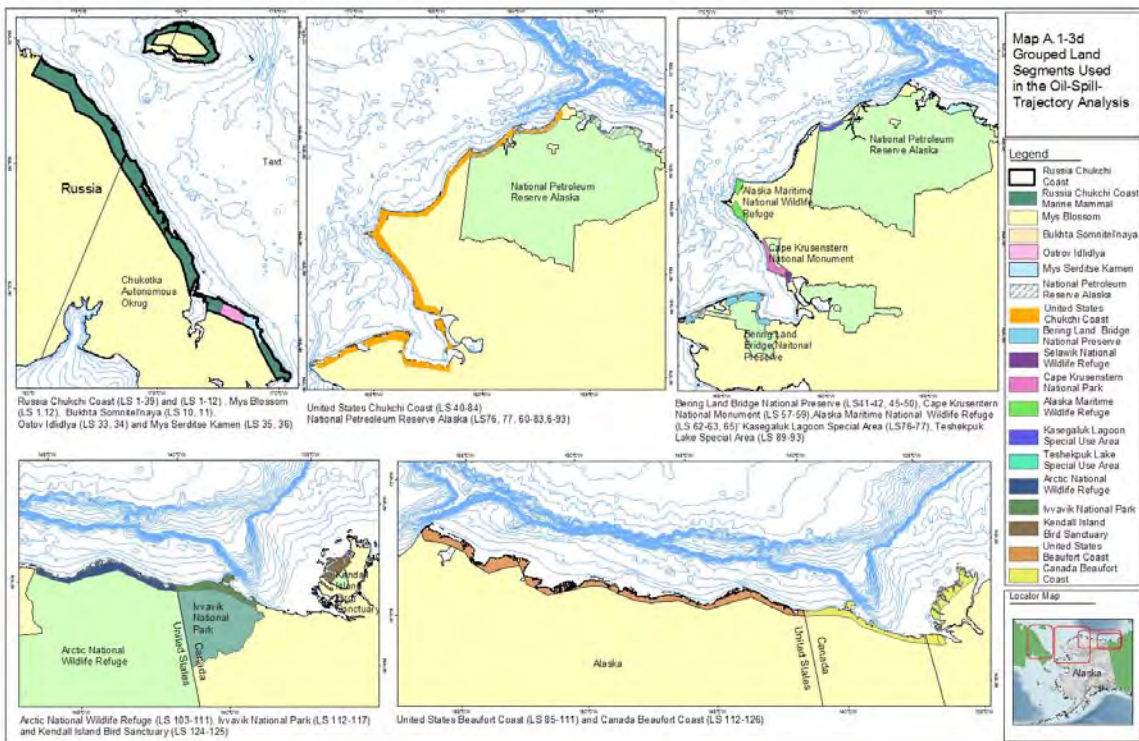


Figure 10 Map A. 1-3d Grouped Land Segments Used in the Oil Spill Trajectory Analysis.

Some LSs were grouped together to represent larger geographic places. These GLSs, their names, and the individual LSs that make them up are shown in Table A.1-22, and their spatial location is shown on Map A.1-3d.

3.1.5. Location of Hypothetical Launch Areas and Hypothetical Pipeline Segments

The BOEMRE does not know where companies may explore, and eventually develop resources, or even if resources will be developed at all. Although BOEMRE know some areas could be more likely than others, BOEMRE needs to look at all of the areas that are open to exploration activities and cover those areas in a hypothetical oil-spill analysis. The maps of launch areas (LAs) and pipeline segments (PLs) are hypothetical locations meant to cover the Beaufort Sea and Chukchi Sea areas for analysis and are not meant to represent or suggest any particular development scenario. If and when any commercial hydrocarbons are discovered, detailed development scenarios would be engineered, designed, reviewed, and evaluated. An oil spill analysis would be included in an EIS on a development and production plan.

3.1.5.1. Beaufort Sea

Map A.1-4a shows the location of the Beaufort 20 hypothetical LAs (LAs 1-20) and 17 hypothetical PLs (PLs 1-17). For this proposed action the sites where large oil spills could originate if they were to occur for, the Proposed Action include LAs 1-20 (Map A1-4b). The LAs divide the area into smaller areas. Pipeline locations are entirely hypothetical. They do not represent proposed pipelines or any planned pipeline locations. They are spaced along the coast to evaluate differences in oil-spill trajectories from different spatial locations along the coast.

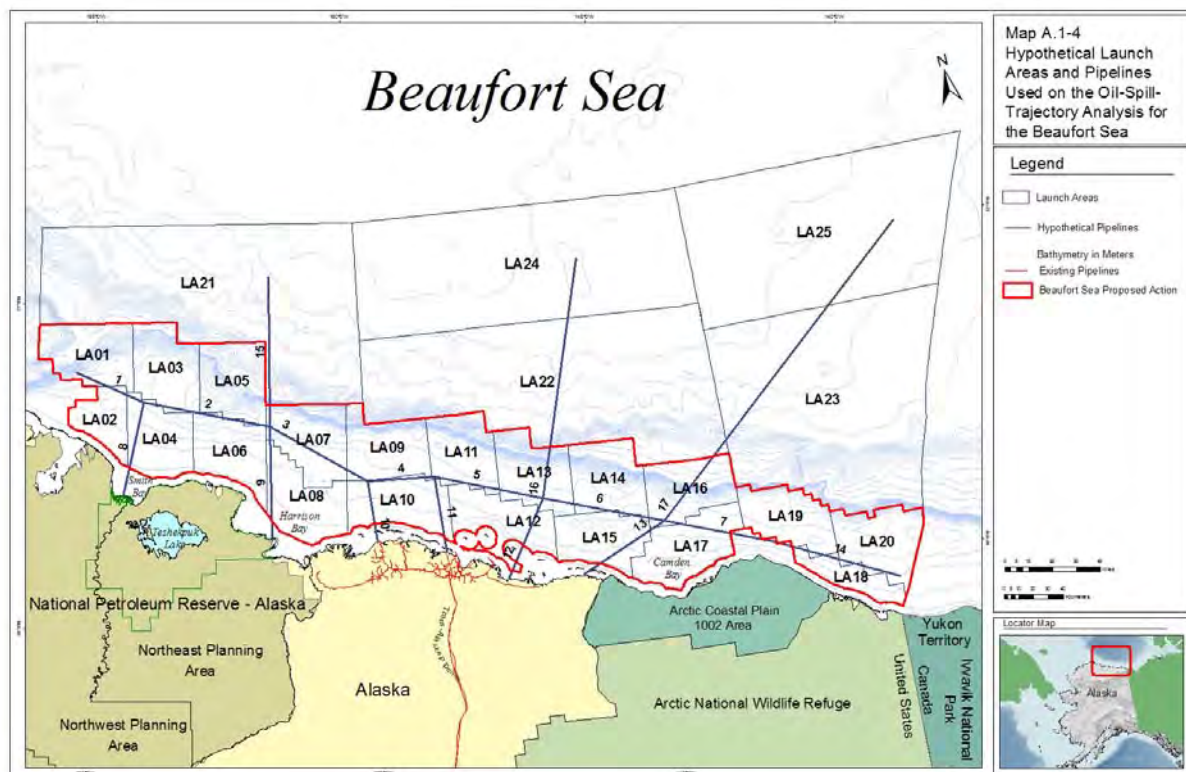


Figure 11 Map A.1-4 Hypothetical Launch Areas and Pipelines Used on the Oil Spill Trajectory Analysis for the Beaufort Sea.

Hypothetical launch points were spaced at one-seventh-degree to two-tenth-degree intervals in the north-south direction (about 15.86-22.5 kilometers [km]) and one-third-degree to one-half-degree intervals in the east-west direction (about 12.67-14.36 km). At this resolution, there were 794 total launch points in space, grouped into 25 LAs of which 20 were used in this biological evaluation.

A total of 2,700 trajectories (2,025 in winter; 675 in summer) from each hypothetical launch point over the 15 years of wind data (1982-1996) and the results of these trajectory simulations were combined to represent platform spills from LAs (Map A.1-4). Launch Areas 2, 4, 6, 8, 10, 12, 15, 17, and 18 begin 3 miles (mi) offshore. Launch Areas 1, 3, 5, 7, 9, 11, 13, 14, 16, 19, and 20 begin 12-35 mi offshore. Launch Areas 21-25 begin approximately 43-57 mi offshore and were not used in this

proposed action. Pipeline spills were represented by 2,700 trajectories (2,025 in winter; 675 in summer) launched from each grid point along each hypothetical PL (1-17, Map A.1-4).

For the Beaufort Sea proposed action, BOEMRE assumes no large oil spills occur during exploration activities. Development/production activities for this proposed action could occur in any of the LAs (1-20) or along any of the PL (1-17). Table A.1-23 shows the assumptions for how launch areas are serviced by hypothetical pipelines.

3.1.5.2. Chukchi Sea

Map A.1-5a shows the location of the Chukchi 13 hypothetical LAs (1-13) and 11 hypothetical PLs (1-11) from five hypothetical pipelines. For this proposed action the sites where large oil spills could originate if they were to occur for the Proposed Action include LAs 1-13. Pipeline locations are entirely hypothetical. They are not meant to represent five proposed pipelines or any real or planned pipeline locations. They are spaced along the coast to evaluate differences in oil-spill trajectories from different locations along the coast.

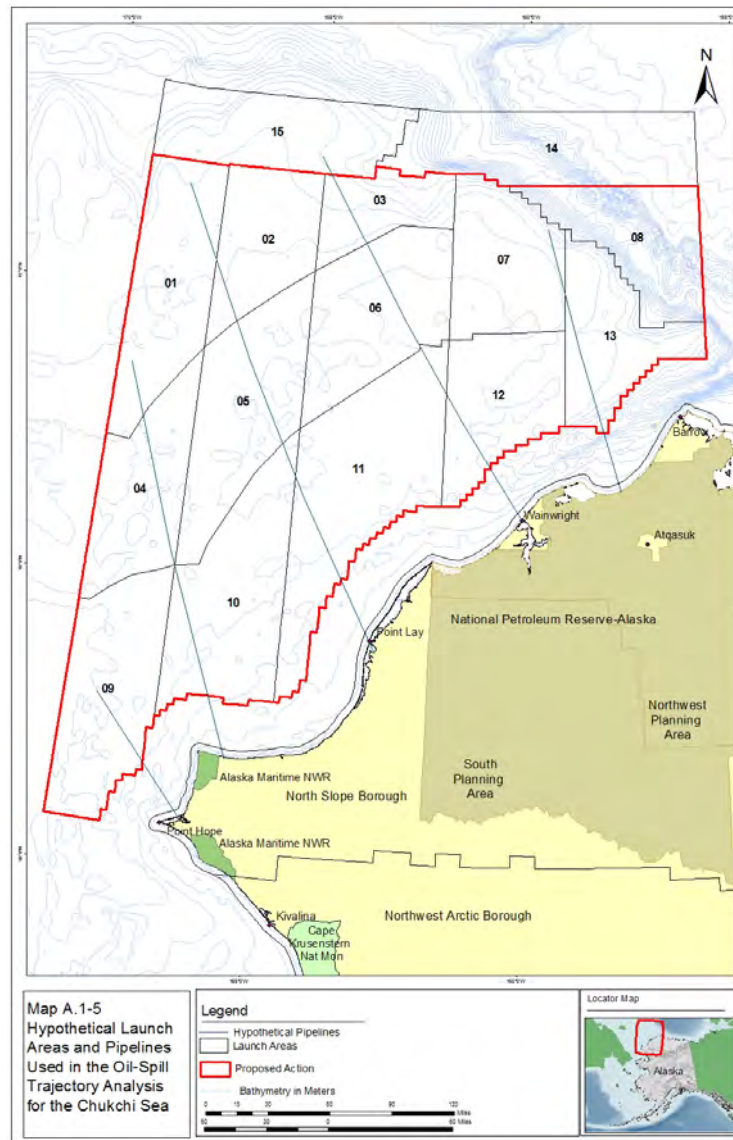


Figure 12 Map A. 1-5 Hypothetical Launch Areas and Pipelines Used on the Oil Spill Trajectory Analysis for the Chukchi Sea.

Hypothetical launch points were spaced at one-seventh-degree intervals in the north-south direction (about 15.86 km) and one-third-degree intervals in the east-west direction (about 12.67 km). At this

resolution, there were 801 total launch points in space, grouped into 15 LAs of which 13 are used in this biological evaluation.

A total of 2,700 trajectories (1,575 in winter; 1,125 in summer) from each hypothetical launch point over the 15 years of wind data (1982-1996) and the results of these trajectory simulations were combined to represent platform spills from the LAs (Map A.1-5). LAs 1-3, 14, and 15 are >150 mi offshore. Launch Areas 4-7 are approximately 90-150 mi offshore. Launch Areas 9-13 are approximately 25-90 mi offshore. Pipeline spills were represented by 2,700 trajectories (1,575 in winter; 1,125 in summer) launched from each grid point along each PL (1-11, Map A.1-5).

For the Chukchi Sea BOEMRE assumes no large oil spills occur during exploration activities. Development/production activities for the Chukchi Sea could occur in any of the LAs (1-13) or along any of the PL (1-11). Table A.1-24 shows the assumptions about how launch areas were serviced by hypothetical pipelines.

3.1.6. Current and Ice Information from a General Circulation Model

For the Beaufort and Chukchi Seas, BOEMRE uses two general circulation models to simulate currents (U_{current}) or ice (U_{ice}), depending on whether the location is nearshore or offshore.

3.1.6.1. Offshore

Offshore of the 10- to 20-meter (m) bathymetry contour, the wind-driven and density-induced ocean-flow fields and the ice-motion fields are simulated using a three-dimensional, coupled, ice-ocean hydrodynamic model (Haidvogel, Hedstrom, and Francis, 2001). The model is based on the ocean model of Haidvogel, Wilkin, and Young (1991) and the ice models of Hibler (1979) and Mellor and Kantha (1989). This model simulates flow properties and sea-ice evolution in the western Arctic during the years 1982-1996. The coupled system uses the S-Coordinate Rutgers University Model (SCRUM) and Hibler viscous-plastic dynamics and the Mellor and Kantha thermodynamics. It is forced by daily surface geostrophic winds and monthly thermodynamic forces. The model is forced by thermal fields for the years 1982-1996. The thermal fields are interpolated in time from monthly fields. The location of each trajectory at each time interval is used to select the appropriate ice concentration. The pack ice is simulated as it grows and melts. The edge of the pack ice is represented on the model grid. Depending on the ice concentration, either the ice or water velocity with wind drift from the stored results of the Haidvogel, Hedstrom, and Francis (2001) coupled ice-ocean model is used. A major assumption used in this analysis is that the ice-motion velocities and the ocean daily flows calculated by the coupled ice-ocean model adequately represent the flow components. Comparisons with data illustrate that the model captures the first-order transport and the dominant flow (Haidvogel, Hedstrom, and Francis, 2001).

3.1.6.2. Nearshore

Inshore of the 10- to 20-m bathymetry contour in the Beaufort Sea, U_{current} is simulated using a two-dimensional (2D) hydrodynamic model developed by the National Oceanic and Atmospheric Administration (NOAA) (Galt, 1980, Galt and Payton, 1981). This model does not have an ice component. The 2D model incorporated the barrier islands in addition to the coastline. The model of the shallow water is based on the wind forcing and the continuity equation. The model was originally developed to simulate wind-driven, shallow-water dynamics in lagoons and shallow coastal areas with a complex shoreline. The solutions are determined by a finite element model, where the primary balance is between the wind forcing friction, the pressure gradients, coriolis accelerations, and the bottom friction. The time dependencies are considered small, and the solution is determined by iteration of the velocity and sea level equations, until the balanced solution is calculated. The wind is the primary forcing function, and a sea-level boundary condition of no anomaly produced by the particular wind stress is applied far offshore, the northern boundary of the oil-spill-trajectory analysis domain.

The results of the model were compared with current meter data from the Endicott Environmental Monitoring Program to determine if the model was simulating the first order transport and the

dominant flow. The model simulation was similar to the current meter velocities during summer. Example time series from 1985 show the current flow at Endicott Station (ED1) for the U (east-west) and V (north-south) components plotted on the same axis with the current derived from the NOAA model for U and V (Der-U and Der-V). The series show that many events coincide in time and that the currents derived from the NOAA model generally are in good correspondence with the measured currents. Some of the events in the measured currents are not particularly well represented, which probably is due to forcing of the current by something other than wind, such as low frequency alongshore wave motions.

3.1.6.3. Landfast Ice Mask

In both the offshore and nearshore models, BOEMRE added an ice mask within the 0-m and approximately 10- to 20-m water-depth contours to simulate the observed shorefast-ice zone. For each month October through June BOEMRE applies the monthly ice mask, one for each of those months. For the Beaufort Sea and a portion of the Chukchi Sea, the landfast ice mask was derived from the minimum landfast ice observed each month from October to June in a study titled Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort and Chukchi Seas (Eiken et al., 2006). For the southern Chukchi Sea to the Bering Strait, the landfast ice mask was taken from Stringer, Barrett, and Schreurs (1980) and was applied from December to May. The Canadian Beaufort minimum landfast ice limit was taken from Arctic Environmental Sensitivity Atlas System produced by Environment Canada (2000) and is applied October to June. The documentation in the Arctic Environmental Atlas describes the sources of that data as follows:

1. ATMOSPHERIC ENVIRONMENT SERVICE. 1974-1986. Canadian Ice Charts. Ice Forecasting Central, Environment Canada, Ottawa.
2. CANADA CENTRE FOR REMOTE SENSING. 1973-1983. Selected LANDSAT Imagery. Energy, Mines and Resources Canada, Ottawa.
3. SPEDDING, L.G. and B.W. DANIELEWICZ. 1983. Artificial Islands and Their Effect on Regional Landfast Ice Conditions in the Beaufort Sea. Joint Report Esso Resources Canada Limited and Dome Petroleum Limited, Calgary.

For the Russian Chukchi coast landfast minimum, BOEMRE reviewed monthly National Ice Center data in ArcGIS for the period 1979-2004. BOEMRE applied a query to distinguish landfast ice. BOEMRE conservatively placed the minimum landfast ice line between the 10- and 20-m contours for the months in which landfast ice was present along the coast (Oct.-June). U_{ice} is zero for the landfast ice mask for the months in which it is applied.

3.1.7. Wind Information

BOEMRE uses 15 of the 17-year reanalysis of the wind fields provided by Rutgers. The TIROS Operational Vertical Sounder (TOVS) has flown on NOAA polar-orbiting satellites since 1978. Available from July 7, 1979, through December 31, 1996, and stored in Hierarchical Data Format, the TOVS Pathfinder (Path-P) dataset provides observations of areas poleward of lat. 60° N. at a resolution of approximately 100 x 100 km. The TOVS Path-P data were obtained using a modified version of the Improved Initialization Inversion Algorithm (3I) (Chedin et al., 1985), a physical-statistical retrieval method improved for use in identifying geophysical variables in snow- and ice-covered areas (Francis, 1994). Designed to address the particular needs of the polar-research community, the dataset is centered on the North Pole and has been gridded using an equal-area azimuthal projection, a version of the Equal-Area Scalable Earth-Grid (EASE-Grid) (Armstrong and Brodzik, 1995).

Preparation of a basinwide set of surface-forcing fields for the years 1980 through 1996 has been completed (Francis, 1999). Improved atmospheric forcing fields were obtained by using the bulk boundary-layer stratification derived from the TOVS temperature profiles to correct the 10-m level geostrophic winds computed from the National Center for Environmental Prediction Reanalysis surface-pressure fields. These winds are compared with observations from field experiments and

coastal stations in the Arctic Basin and have an accuracy of approximately 10% in magnitude and 20° in direction.

3.1.8. Large Oil-Spill-Release Scenario

For purposes of this trajectory simulation, all spills occur instantaneously. For each trajectory simulation, the start time for the first trajectory was the first day of the season (winter or summer) of the first year of wind data (1982) at 6:00 a.m. Greenwich Mean Time (GMT). Each subsequent trajectory was started every 2 days at 6:00 a.m. GMT. The spatial resolution of the trajectory simulations was well within the spatial resolution of the input data, and the interval of time between releases was sufficiently short to sample weather-scale changes in the input winds (Price et al., 2004).

3.2. Oil-Spill-Trajectory Model Assumptions

The oil-spill-trajectory model assumptions are as follows:

- Large oil spills occur in the hypothetical launch areas or along hypothetical pipeline segments.
- Companies transport the produced oil through pipelines.
- A large oil spill reaches the water.
- Large oil spills persist long enough for trajectory modeling for up to 360 days if they are encapsulated in ice and melt out.
- A large oil spill encapsulated in the landfast ice does not move until the ice moves or it melts out.
- Large oil spills occur and move without consideration of weathering. The oil spills are simulated each as a point with no mass or volume. The weathering of the oil is estimated in the stand-alone SINTEF OWM model.
- Large oil spills occur and move without any cleanup. The model does not simulate cleanup scenarios. The oil-spill trajectories move as though no booms, skimmers, or any other response action is taken.
- Large oil spills stop when they contact the mainland coastline, but not the offshore barrier islands in Stefansson Sound.

Uncertainties about oil spills exist, such as

- the actual size of the large oil spill or spills, should they occur;
- whether the large spill reaches the water;
- whether the large spill is instantaneous or a long-term leak;
- the wind, current, and ice conditions at the time of a possible large oil spill;
- how effective cleanup is;
- the characteristics of crude, condensate or diesel oil at the time of the large spill;
- how Alpine composite or Alaska North Slope crude oil will spread; and
- whether or not development and production occurs.

3.3. Oil-Spill-Trajectory Simulation

The trajectory-simulation portion of the model consists of many hypothetical oil-spill trajectories that collectively represent the mean surface transport and the variability of the surface transport as a function of time and space. The trajectories represent the Lagrangian motion that a particle on the surface might take under given wind, ice, and ocean-current conditions. Multiple trajectories are simulated to give a statistical representation, over time and space, of possible transport under the range of wind, ice, and ocean-current conditions that exist in the area.

Trajectories are constructed from simulations of wind-driven and density-induced ocean flow fields and the ice-motion field. The basic approach is to simulate these time- and spatially dependent currents separately and then combine them through linear superposition to produce an oil-transport vector. This vector is then used to create a trajectory. Simulations are performed for three seasons:

winter, summer, and annual. The choice of this seasonal division was based on meteorological, climatological, and biological cycles and consultation with Alaska OCS Region analysts.

For cases where the ice concentration is below 80%, each trajectory is constructed using vector addition of the ocean current field and 3.5% of the instantaneous wind field—a method based on work done by Huang and Monastero (1982), Smith et al. (1982), and Stolzenbach et al. (1977). For cases where the ice concentration is 80% or greater, the model ice velocity is used to transport the oil. Equations 1 and 2 show the components of motion that are simulated and used to describe the oil transport for each spillite:

1. $U_{oil} = U_{current} + 0.035 U_{wind}$ or
2. $U_{oil} = U_{ice}$

where:

- U_{oil} = oil drift vector
- $U_{current}$ = current vector (when ice concentration is <80%)
- U_{wind} = wind speed at 10 m above the sea surface
- U_{ice} = ice vector (when ice concentration is $\geq 80\%$)

The wind-drift factor was estimated to be 0.035, with a variable drift angle ranging from 0°-25° clockwise. The drift angle was computed as a function of wind speed according to the formula in Samuels, Huang, and Amstutz (1982). The drift angle is inversely related to wind speed.

The trajectories age while they are in the water and/or on the ice. For each day that the hypothetical spill is in the water, the spill ages—up to a total of 360 days. While the spill is in the ice ($\geq 80\%$ concentration), the aging process is suspended. The maximum time allowed for the transport of oil in the ice is 360 days, after which the trajectory is terminated. After coming out of the ice, into open water, the trajectory ages to a maximum of 30 days.

3.4. Results of the Oil-Spill-Trajectory Model

The output of the oil-spill-trajectory simulation is a set of results called a conditional probability. Below is the definition of a conditional probability and how it is applied, the location of the conditional probability tables and a brief synopsis of the results.

3.4.1. Conditional Probabilities: Definition and Application

The chance that a large oil spill will contact a specific ERA including land, LS, SLS, GLS, or boundary segment within a given time of travel from a certain location (LA or PL) is termed a conditional probability. The condition is that BOEMRE assumes a large spill occurs. Conditional probabilities assume a large spill has occurred and the transport of the spilled oil depends only on the winds, ice, and ocean currents in the study area. Conditional probabilities are reported for three seasons (annual, summer, and winter) and six time periods (3, 10, 30, 60, 180, and 360 days). Conditional probabilities are expressed as a percent chance. This means that the probability (a fractional number between 0 and 1) is multiplied by 100 and expressed as a percentage.

For the Beaufort Sea and the Chukchi Sea, annual, summer, and winter periods are shown in Section 3.1.2. Contact to an ERA or LS tabulated from a trajectory that began before the end of summer is considered a summer contact. BOEMRE also estimates the conditional probability of contact from spills that start in winter, freeze into the pack ice or landfast ice, and melt out in spring. Winter contacts are from spills that begin in winter. Therefore, if any contact to an ERA or LS is made by a trajectory that began by the end of winter, it is considered a winter contact. BOEMRE also estimates annual conditional probabilities of contact within 3, 10, 30, 60, 180, and 360 days. Annual contact is for a trajectory that is launched any month throughout the entire year.

3.4.1.1. Conditional Probabilities: Results

The chance of a large spill contacting, assuming a spill has occurred, is called a conditional probability. It is conditioned on the fact that a large spill has occurred. The oil-spill-trajectory model conditional probability results are summarized generally below and listed in Tables A.2-1 through A.2-156 for the Beaufort Sea and Tables A.3-1 through A.3-78 for the Chukchi Sea (USDOI, MMS, 2008). Conditional probability tables used in the BE large oil spill analysis sections are included. The maps for the ERAs are Map A.1-2a through Map A.1-2d and the LSs are Map A.1-3a through A.1-3c. For specific analysis of conditional probabilities in regard to specific resources, please see the Oil Spill Analysis Sections in this Biological Evaluation. Probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model (expressed as percent chance) of a spill $\geq 1,000$ bbl contacting ERAs and LSs within the days and seasons as specified below.

3.4.1.1.1. Beaufort Comparisons between Spill Location and Season

The primary differences of contact between spill locations are geographic in the perspective of west to east and nearshore versus offshore. Offshore spill locations take longer to contact the coast and nearshore ERAs, if contact occurs at all. Winter spill contact to nearshore and coastal resources is less often and, to a lesser extent, due to the landfast ice in place from October to June.

3.4.1.1.2. Chukchi Comparisons between Spill Location and Season

The primary differences of contact between hypothetical LAs and PLs are geographic in the perspective of west to east and nearshore versus offshore and temporal in terms of how long it takes to contact. Offshore spill locations take longer to contact the coast and nearshore ERAs, if contact occurs at all. Winter spill contact to nearshore and coastal resources is less often and, to a lesser extent, due to the landfast ice in place from December to April. Hypothetical spills have a stochastic northerly or southwesterly direction of spread.

The western edge of the proposed Chukchi lease area is adjacent to Russian territory. The chance of a large oil spill contacting ERA7 (U.S./Russia maritime boundary) from LAs 1-15 or PLs 1-11 is 76% or less within 30 days (Tables A.3-1 through A.3-6, USDOI, MMS 2008).

4.0 OIL-SPILL-RISK ANALYSIS

A measure of oil-spill risk is determined by looking at the chance of one or more large spills occurring and then contacting a resource of concern. This analysis helps determine the relative spill occurrence and contact associated with oil and gas production in different regions of the area. Combined probabilities are the chance of one or more large spills occurring and contacting. They are estimated using the conditional probabilities, the oil-spill rates, the resource estimates, and the assumed transportation scenarios. These are combined through matrix multiplication to estimate the mean number of one or more large spills occurring and contacting.

4.1. Chance of One or More Large Spills Occurring

The chance of one or more large spills occurring is derived from two components: (1) the spill rate and (2) the resource-volume estimates. The spill rate is multiplied by the resource volume to estimate the mean number of spills. Oil spills are treated statistically as a Poisson process, meaning that they occur independently of one another. If BOEMRE constructed a histogram of the chance of exactly 0 spills occurring during some period, the chance of exactly 1 spill, 2 spills, and so on, the histogram would have a shape known as a Poisson distribution. An important and interesting feature of this distribution is that it is entirely described by a single parameter, the mean number of spills. Given the mean number of spills, you can calculate the entire histogram and estimate the chance of one or more large spills occurring.

4.1.1. Large Spill Rates

BOEMRE derives the large oil-spill rates from a fault-tree modeling studies done by the Bercha Group, Inc. (2006, 2008). These studies examined alternative oil-spill-occurrence estimators for the Chukchi and Beaufort seas using a fault-tree method. Using fault trees, oil-spill data from the Gulf of Mexico were modified and incremented to represent expected Arctic performance and included both Arctic and non-Arctic variability. The discussion of fault-tree analyses is incorporated by reference from Beaufort Sea Sales 186, 195, and 202 final EIS and Chukchi Sea Sale 193 FEIS, Appendix A (USDOI, MMS, 2003a, 2007d) and Beaufort Sales 195 and 202 EAs (USDOI, MMS 2004, 2006b) and is summarized below.

Fault-tree analysis is a method for estimating the spill rate resulting from the interactions of other events. Fault trees are logical structures that describe the causal relationship between the basic system components and events resulting in system failure. Fault-tree models are a graphical technique that provides a systematic description of the combinations of possible occurrences in a system, which can result in an undesirable outcome. Figure A-5 shows the generalized parts of a fault tree starting with the top event. The top event is defined as the failure under investigation. In this case, it is either a large pipeline or platform spill. A series of events that lead to the top event are described and connected by logic gates. Logic gates define the mathematical operations conducted between events.

Two general fault trees are constructed, one for large pipeline spills and one for large platform spills. The pipeline fault-tree events included corrosion, third-party impact, operation impact, mechanical failure, and natural hazards—unknown and Arctic. The sub-resultant events that make up Arctic include upheaval buckling, ice strudel scour, ice scour, thaw settlement, and other. Platform events include a process facility release, a storage tank release, structural failure, hurricane or storm, collision, and Arctic. The sub-resultant events that make up the Arctic included; ice force, low temperature, and others.

In the Bercha Group Inc. (2006, 2008) studies, fault trees were used to transform historical spill statistics for non-Arctic regions to predictive spill-occurrence estimates for the Beaufort and Chukchi seas' program area. The Bercha Group, Inc. (2008) fault-tree analysis focused on Arctic effects as well as the variance in non-Arctic effects, such as spill size and spill frequency. Arctic effects were treated as a modification of existing spill causes as well as unique spill causes. Modification of existing spill causes included those that also occur in other OCS regions but at a different frequency, such as trawling accidents. Unique spill causes included events that occur only in the Arctic, such as ice gouging, strudel scour, upheaval buckling, thaw settlement, and other for pipelines. For platforms, unique spill causes included ice force, low temperature, and other.

Treatment of Uncertainties

The measures of uncertainty calculated were expanded beyond Arctic effects in each fault-tree event to include the non-Arctic variability in spill size, spill frequency, and facility parameters, including wells drilled, number of platforms, and subsea wells and subsea pipeline length. The inclusion of these types of variability—Arctic effects, non-Arctic data and facility parameters—is intended to provide a realistic estimate of spill-occurrence indicators and their resultant variability.

4.1.1.1. Results for Development Spill Rates

For purposes of analysis, BOEMRE uses the upper range of the Beaufort development scenario. The annual rates were weighted by the annual production over the total production or the year over the total years, and the prorated rates were summed to determine the rates over the life of the production. For the Beaufort Sea, the life of production for the three-development case is 20 years. For the Chukchi Sea, the life of production for the one-development case is 25 years. Bercha Group, Inc. (2006, 2008) calculated 95% confidence intervals on the total spill rate per billion barrels as shown below:

4.1.1.1.1. Beaufort

3 Developments, 20-Year Production Life

Type	Mean
Platforms/Wells	0.29 spills per billion barrels produced
Pipelines	0.29 spills per billion barrels produced
Total	0.58 spills per billion barrels produced
95% Confidence Interval	0.26-0.78 spills per billion barrels produced

4.1.1.1.2. Chukchi

1 Development, 25-Year Production Life

Type	Mean
Platforms/Wells	0.21 spills per billion barrels produced
Pipelines	0.30 spills per billion barrels produced
Total	0.51 spills per billion barrels produced
95% Confidence Interval	0.32-0.77 spills per billion barrels produced

Confidence Interval

A confidence interval is a range of values that describes the uncertainty surrounding an estimate. A confidence interval is also itself an estimate. It is made using a model of how sampling, measuring, and modeling contributes to uncertainty about the relation between the true value of the quantity BOEMRE is estimating and our estimate of that value. The “95%” confidence interval listed represents a level of certainty about our estimate. If BOEMRE were to repeatedly make new estimates using exactly the same procedure (by drawing a new sample, calculating new estimates and new confidence intervals), the confidence intervals would contain the average of all the estimates 95% of the time. BOEMRE has, therefore, produced a single estimate in a way that, if repeated indefinitely, would result in 95% of the confidence intervals formed containing the true value. Confidence intervals are one way to represent how “good” an estimate is; the larger a 95% confidence interval for a particular estimate, the more caution is required when using the estimate. Confidence intervals are an important reminder of the limitations of the estimates.

4.1.2. Resource-Volume Estimates

The resource volume estimates and resource development scenarios are discussed below.

4.1.3. Transportation Assumptions

Appendix A.1, Section 3.1.5 – Estimates of Where an Oil Spill May Go discusses the transportation assumptions for the launch areas and their associated hypothetical pipelines.

4.1.4. Results for the Chance of One or More Large Spills Occurring

The chance of one or more large spills occurring does not factor in the chance that a development project occurs. Given the many logistical, economic, and engineering factors, there probably is a <10% chance that a commercial field will be leased, discovered, and developed. However, because leasing and exploration could lead to a development project, BOEMRE must evaluate what would happen if a development occurred, even though the chance of that happening probably is very small in a frontier areas like the Beaufort and Chukchi seas. Our estimate of one or more large spills occurring assumes there is a 100% chance that development(s) will occur and oil will be produced. Clearly, this overstates the oil-spill occurrence associated with leasing and exploration where it is unlikely a development will occur from those activities. If a development occurs, this oil-spill analysis more accurately represents the chance of one or more large spills occurring.

Additionally, the chance of one or more large spills occurring is estimated over the entire production life of the development(s). For the Beaufort Sea, production is assumed to occur over 20 years; for the Chukchi Sea, production is assumed to occur over 25 years. The estimates of one or more large spills

occurring add up the annual chances for both pipeline and platforms over the estimated 20- to 25-year production life of the development(s).

4.1.4.1. Beaufort

The chance of one or more large spills occurring assumes there is a 100% chance that a project or projects will be developed and 0.5 Bbbl of oil will be produced from each sale. The large spill rates used in this section are all based on spills per billion barrels. Using the above mean large spill rates, Table A.1-25 shows the estimated mean number of large oil spills for the Proposed Action. BOEMRE estimate 0.15 pipeline spills and 0.15 platform (and well) spills for a total over the 20-year life of proposed action production of 0.30 spills. Although statistically BOEMRE estimates less than one spill will occur, for purposes of analysis, one large spill was assumed to occur and was analyzed in referenced NEPA documents.

Using the above mean spill rates, Table A.1-26 shows the chance of no pipeline spills occurring is 86% and the chance of one or more large pipeline spills occurring is 14%. The chance of no large platform spills occurring is 86% and the chance of one or more large platform (wells and platform) spills is 14% for the Proposed Action over the 20-year production life. The total is derived from the sum of the platform, wells, and pipeline mean number of spills over the entire 20-year production life. The chance of no large spills occurring is 74%, and the chance of one or more large spills total occurring is 26% for the Proposed Action over the 20-year production life. Figure A.1-4 shows the Poisson distribution.

4.1.4.2. Chukchi

The chance of one or more large spills occurring assumes there is a 100% chance that a project will be developed and 1 Bbbl of oil will be produced. The large spill rates used in this section are all based on spills per billion barrels.

Using the above mean large spill rates, Table A.1-27 shows the estimated mean number of large oil spills for the Proposed Action. For the Proposed Action BOEMRE estimates 0.30 pipeline spills and 0.21 platform (and well) spills for a total over the 25-year production life of 0.51 spills. For purposes of analysis, one large spill was assumed to occur and was analyzed in referenced NEPA documents.

Using the above mean spill rates, Table A.1-28 shows the chance of no pipeline spills occurring is 74%, and the chance of one or more large pipeline spills occurring is 26%. The chance of no large platform spills occurring is 81% and the chance of one or more large platform (wells and platform) spills is 19% the Proposed Action over the 25-year production life. The total is derived from the sum of the platform, wells, and pipeline mean number of spills added together over the entire 25-year production life. The chance of no spills occurring is 60%, and the chance of one or more large spills total occurring is 40% for the Proposed Action over the 25-year production life. Figure A.1-5 shows the Poisson distribution.

4.2. Chance of a Large Spill Contacting ERAs or LSs

The chance of a large spill contacting ERAs or LSs is taken from the oil-spill-trajectory model results, called conditional probabilities, summarized in Section 3.4.2.2 and listed in Tables A.2-1 through A.2-156 and in Tables A.3-1 through A.3-78 (USDOI, MMS 2008).

4.3. Results of the Oil-Spill-Risk Analysis: Combined Probabilities

The combined probabilities reflect the chance of one or more large spills occurring and contacting ERAs or LSs over the assumed production life of the lease area.

4.3.1. Beaufort

For the most part, the chance of one or more large spills occurring and contacting environmental resource areas and land segments is 4% or less over 30 days, or 17% or less over 360 days for the Proposed Action. For environmental resource areas with a chance of occurrence and contact $\geq 0.5\%$,

the chance of one or more large spills occurring and contacting a certain environmental resource area ranges from 1-1%, 1-2%, and 1-4% within 3, 10, and 30 days, respectively, for the Proposed Action. For the Proposed Action, all land segments have a <0.5% chance of one or more large spills occurring and contacting within 30 days. Within 60 days, LS 92 (Cape Halkett) has a 1% chance of one or more large spills occurring and contacting that LS.

4.3.2. Chukchi

For the most part, the chance of one or more large spills occurring and contacting environmental resource areas and land segments is 13% or less over 30 days, or 17% or less over 360 days for the Proposed Action. For environmental resource areas with a chance of occurrence and contact $\geq 0.5\%$, the chance of one or more large spills occurring and contacting a certain environmental resource areas ranges from 1-8%, 1-10%, and 1-13% within 3, 10, and 30 days, respectively, for the Proposed Action. For the Proposed Action, land segments with a 1% chance of one or more spills occurring and contacting after 30 days include LSs 72 (Point Lay), 73 (Tungaich Point), 74 (Kasegaluk Lagoon), and 75 (Icy Cape).

5.0 ACCIDENTAL SMALL OIL SPILLS

Small spills are spills that are <1,000 bbl. Tables A.1-1 and A.1-2 show the sections names under oil spill analysis in this BE where BOEMRE analyzes the effects of small spill(s). BOEMRE considers two oil types for small spills: crude oil and refined oil.

The analysis of Alaska North Slope small spills in USDOJ, MMS (2003a, 2007d) are incorporated by reference. Brief summaries of these descriptions, updated and augmented by new material, are provided below. BOEMRE expects the same companies and regulators to participate offshore in the Beaufort and Chukchi seas as those that are now operating on the onshore Alaska North Slope. BOEMRE expects similar but not exact environmental conditions. BOEMRE believes it is reasonable to assume that the rate in the Beaufort and Chukchi seas will be similar to the rate on the Alaska North Slope. The OCS rate of crude and refined small spills is approximately 3,460 spills per billion barrels, and the North Slope rate is approximately 618 spills per billion barrels. For whatever reason, the small spill rate on the Alaska North Slope is significantly less than the OCS rate.

The analysis of operational small oil spills uses historical oil-spill databases and simple statistical methods to derive general information about small crude and refined oil spills that occur on the Alaska North Slope. This information includes estimates of how often a spill occurs for every billion barrels of oil produced (oil-spill rates), the mean (average) number of oil spills, and the mean and median size of oil spills from facilities, pipelines, and flowlines combined. BOEMRE then uses this information to estimate the number, size, and distribution of operational small spills that may occur from the Beaufort Sea or the Chukchi Sea. The analysis of operational small oil spills considers the entire production life of the Beaufort or Chukchi seas' sales and assumes the following:

- commercial quantities of hydrocarbons are present in the multiple-sale Program Area, and
- these hydrocarbons will be developed and produced at the estimated resource levels.
- Uncertainties exist, such as
- the estimates required for the assumed resource levels, or
- the actual size of a crude- or refined-oil spill.

BOEMRE uses the history of crude and refined oil spills reported to the State of Alaska, Department of Environmental Conservation (ADEC) and the Joint Pipeline Office to determine crude and refined oil-spill rates and patterns from Alaska North Slope oil and gas exploration and development activities for spills ≥ 1 gal and <1,000 bbl. Refined oil includes aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The Alaska North Slope oil-spill analysis includes onshore oil and gas exploration and development spills from the Point Thompson Unit, Badami Unit, Kuparuk River Unit, Milne Point Unit, Prudhoe Bay West Operating Area, Prudhoe Bay East Operating Area, and Duck Island Unit.

The Alaska North Slope oil-spill database of all spills ≥ 1 gal is from ADEC. Oil-spill information is provided to ADEC by private industry according to the State of Alaska Regulations 18 AAC 75. The totals are based on initial spill reports and may not contain updated information. The ADEC database integrity is most reliable for the period 1989 and after, due to increased scrutiny after the Exxon Valdez oil spill (Velt, 1997, pers. commun.). For this analysis, the database integrity cannot be validated thoroughly. However, BOEMRE uses this information because it is the only information available to us about small spills. For this analysis, the ADEC database is spot-checked against spill records from ARCO Alaska, Inc. and British Petroleum, Inc. All spills ≥ 1 gal are included in the dataset. BOEMRE uses the time period January 1989 through December 2000 in this analysis of small oil spills for the Chukchi Sea.

A simple analysis of operational small oil spills is performed. Alaska North Slope oil-spill rates are estimated without regard to differentiating operation processes. The ADEC database base structure does not facilitate quantitative analysis of Alaska North Slope oil-spill rates separately for platforms, pipelines, or flowlines. Recently, Everest Consulting Assocs. (2007) performed a similar analysis for small spills < 200 bbl for the time period 1985-2006 and derived similar results.

5.1. Exploration: Small Oil Spills

Section 1.1.5 of this Appendix discusses the historical exploration spills on the Beaufort and Chukchi OCS, all of which are classified as small. Small (50 bbl or less) operational or fuel transfer spills of diesel, refined fuel, or crude oil may occur. The BOEMRE estimates this could be a typical scenario during exploratory drilling in the Beaufort and Chukchi seas. These small spills often are onto containment on platforms, facilities, or gravel islands or onto ice and may be cleaned up.

BOEMRE assumes that small spills could occur during exploration which includes geological and geophysical (G&G) operations or exploration drilling activities. The BOEMRE analyzed hypothetical diesel fuel spills from vessel refueling during G&G operations and exploration drilling in NEPA documents ranging from 5 gallons to 48 barrels (USDOI, MMS, 2006, 2007, 2009a, 2009b, USDOI, BOEMRE 2010a, 2010b, 2011a).

Small fuel transfer spills associated with the vessels used for G&G operations could occur, especially during fuel transfer. For purposes of analysis, BOEMRE estimates a seismic vessel transfer spill could range from < 1 -13 bbl. The < 1 bbl volume assumes that dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume assumes that spill prevention measures fail or fuel lines rupture. For purposes of analysis BOEMRE assumes prevention measures are successful, but refueling spills could range from no fuel spills to one per activity. Table A-1 shows the estimated fuel spills from maximum anticipated annual levels of G&G activities could range from zero if no fuel spills occur to < 9 barrels in each sea if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. There are no reported historical fuel spills from geological or geophysical operations on the Chukchi and Beaufort OCS.

Small fuel transfer spills could also occur during exploration drilling operations. Table A-1-37 shows the estimated fuel transfer spills from maximum anticipated annual levels of exploration drilling activities could range from zero if no fuel transfer spills occur to ≤ 100 barrels in each sea if every operation refuels, every refueling operation has a fuel spill and no oil is recovered during spill response (USDOI, MMS, 2009a, 2009b, USDOI, BOEMRE, 2011a).

Historically, on the Arctic OCS, all but < 3 bbl of the total amount spilled during exploratory drilling was recovered during spill response (Appendix A, Table A.1-4) an average of approximately 3 gallons spilled per well drilled.

Refueling operations for Beaufort Sea operations likely could occur at Prudhoe Bay's West Dock facility, in Tuktoyuktok, Canada or at sea with the use of fuel supply vessels, and refueling operations in the Chukchi Sea likely could occur at sea with the use of fuel supply vessels.

5.2. Development:

For purposes of analysis BOEMRE assumes small spills occur during development. The analysis of small spills discusses both crude and refined oil spills.

5.2.1. Development: Small Crude Oil Spills

The analysis of Alaska North Slope crude oil spills is performed collectively for all facilities, pipelines, and flowlines. The pattern of crude oil spills on the Alaska North Slope is one of numerous small spills, of which the majority are into containment and do not reach the environment. Of the crude oil spills that occurred between 1989 and 2000, 31% were ≤ 2 gal and 55% were ≤ 5 gal. Ninety-eight percent of the crude oil spills were $< 1,050$ gal (25 bbl) and 99% were $< 2,520$ gal (60 bbl). The spill sizes in the database range from < 1 gal–38,850 gal (925 bbl). The average small crude oil-spill size on the Alaska North Slope is 113.4 gal (2.7 bbl), and the median spill size is 5 gal. For purposes of analysis, this analysis assumes an average crude oil-spill size of 126 gal (3 bbl). Everest Consulting Assocs. (2007) determined the median spill size for spills < 200 bbl is 2.1 bbl.

Table A.1-29 shows the estimated crude oil-spill rate for the Alaska North Slope is 178 spills per billion barrels produced for spills < 500 bbl and 0.64 spills per billion barrels produced for spills ≥ 500 bbl. For the Beaufort Sea, Table A.1-30 shows the assumed number, size, and total volume of small spills for the Proposed Action, and Table A.1-31 shows the assumed size distribution of those spills. For the Chukchi Sea, Table A.1-32 shows the assumed number, size, and total volume of small spills for the Proposed Action, and Table A.1-33 shows the assumed size distribution of those spills.

The causes of Alaska North Slope crude oil spills, in decreasing order of occurrence by frequency, are leaks, faulty valve/gauges, vent discharges, faulty connections, ruptured lines, seal failures, human error, and explosions. The cause of approximately 30% of the spills is unknown.

5.2.2. Development Small: Operational Refined Oil Spills

The typical refined products spilled are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. Diesel spills are 58% of refined oil spills by frequency and 83% by volume. Engine lube oil spills are 10% by frequency and 3% by volume. Hydraulic oil is 26% by frequency and 10% by volume. All other categories are $< 1\%$ by frequency and volume. Refined oil spills occur in conjunction with oil exploration and production. The refined oil spills correlate to the volume of Alaska North Slope crude oil produced. As production of crude oil has declined, so has the number of refined oil spills. Table A.1-34 shows that from January 1989–December 2000, the spill rate for refined oil is 440 spills per billion barrels produced. Tables A.1-35 and A.1-36 show the assumed refined oil spills during the lifetime of the Proposed Action for the Beaufort Sea Sales and the Chukchi Sea, respectively.

5.2.3. Development: Small Spill Assumptions for Purposes of Analysis

5.2.3.1. Beaufort

The average crude-oil spill size is 126 gal (3 bbl) for spills < 500 bbl. An estimated 89 small crude oil spills could occur during the 20-24 year oil-production period of each sale for the Proposed Action, (Table A.1-30), an average of more than 4 spills per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined-oil spills would occur during the 20-year oil-production period for the Proposed Action (Table A.1-35), an average of 11 spills per year. Overall, an estimated 15 crude and refined oil spills < 500 bbl would occur each year of production for the Proposed Action.

5.2.3.2. Chukchi

The average crude-oil spill size is 126 gal (3 bbl) for spills < 500 bbl. An estimated 178 small crude oil spills could occur during the 25-year oil-production period for the proposed action (Table A.1-32), an average of more than 7 spills per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 440 refined-oil spills would occur during the 25-year oil-production period for the proposed action (Table A.1-36), an average of 17.6 spills per year. Overall, an estimated 25 crude and refined

oil spills <500 bbl would occur each year of production for the proposed action. The average crude-oil spill size is 680 bbl for spills ≥ 500 bbl. An estimated one small crude oil spill ≥ 500 bbl could occur during the 25-year oil-production period the Proposed Action (Table A.1-32).

6.0 VERY LARGE OIL SPILLS

This section summarizes the estimates the BOEMRE uses to analyze very large oil spills (VLOS) in USDOJ, MMS (2003) and USDOJ, BOEMRE (2011b) and includes the analyses for polar bear, polar bear critical habitat and threatened and endangered birds. BOEMRE defines a VLOS as $\geq 150,000$ bbl. This means that 150,000 bbl is the minimum threshold size. Seven VLOS analyses have been completed in the Arctic OCS (USDOJ MMS, 1990a, 1990b, 1996, 1998, 2002, 2003, USDOJ, BOEMRE 2011b).

A VLOS is an issue of concern. The Gulf of Mexico and Pacific and Alaska OCS data show that a large/very large spill likely would not be from a well-control incident. BOEMRE considers well-control incidents that result in pollution to the environment to be very unlikely events. Well-control incidents often are equated with catastrophic spills; however, in the last 40 years very few OCS well-control incidents have resulted in spilled oil, and the volumes spilled often are small with the exception of the Deepwater Horizon (Section 1.1.6 and Table A.1-3). Five OCS well-control incidents $\geq 1,000$ bbl occurred between 1964 and 1970 and a sixth, the Macondo Well 252 (hereafter called the Deepwater Horizon (DWH) event occurred in 2010 in the Gulf of Mexico (Table A.1-3). Although no official volume has been determined by BOEMRE it is clear from the spill volume estimates that the Deepwater Horizon exceeds the threshold of a VLOS; the current estimate is 4.9 million bbls and is greater than 150,000 barrel threshold for a VLOS (Lubchenco et al. 2010; McNutt et al. 2011).

Following the Santa Barbara well-control incident in 1969 and two large well control incidents in 1970 in the Gulf of Mexico, amendments to the OCS Lands Act and implementing regulations significantly strengthened safety, inspection, and pollution-prevention requirements for OCS offshore activities. Well-control training, redundant pollution-prevention equipment and subsurface safety devices are among the provisions that were adopted in the regulatory program (Visser, 2011). The year 1971 is considered reflective of the modern regulatory environment. For 39 years no OCS well control incidents resulted in a large spill. In 2010 and 2011 new regulations were again implemented to significantly strengthen safety, inspection, and pollution-prevention requirements for OCS offshore activities after the DWH event (USDOJ, BOEMRE, 2011b).

Internationally, from 1965 through 2010, seven offshore oil well control incidents, resulting in an oil spill of greater than or equal to 150,000 bbl, were identified from the peer reviewed or “gray” literature (Table A.1-40). One of the well control incidents was the result of military action. There were roughly 1.066 trillion barrels of oil produced worldwide from 1965–2010 (British Petroleum, 2011). The BOEMRE compares numbers of spills to overall production because the number of exploration and development wells worldwide is not readily available. Using the 6 spills which were not a result of war, these data provide an approximate rate of about 1 very large oil spill worldwide for every 533 Bbbl of oil produced. Using international data increases the size of the data set and is more likely to capture rare events. However, it assumes that non-US events are relevant to US events to the extent that technology, maintenance, operational standards and other factors are equal; but this is not likely to be the case (especially in cases of military action).

6.1. VLOS Scenario

To facilitate analysis of the potential impacts of a VLOS to listed species in the Chukchi or Beaufort Sea, it is first necessary to develop a VLOS scenario. Scenarios are conceptual views of the future and represent possible sets of activities. They serve as planning and analytical tools that make possible an objective and organized analysis of hypothetical events. This VLOS scenario is not to be confused with what would be anticipated to occur as a result of potential specific activities on the OCS.

The VLOS scenario is similar to worst-case discharge (WCD) analysis, calculated for NTL 2010-06, to the extent that both calculations are performed using similar assumptions and similar analytical methods. However, these calculations differ in several important ways. Rather than analyzing a specific drilling proposal, the VLOS scenario maximizes the variables driving high flow rates at the time it was developed. Site-specific WCDs at sites across the subject area would typically result in much lower initial rates and aggregate discharges if discharge periods are held equal. The calculations also differ in their purpose. Whereas the VLOS scenario is a planning tool for environmental impacts analysis, a WCD is the calculation required by 30 CFR parts 250 to accompany an Exploration Plan and provide a basis for an Oil Spill Response Plan as well as NTL 2010-06.

The VLOS scenario is predicated on an unlikely event—a loss of well control during exploration or development drilling that leads to a long duration blowout and a resulting VLOS. Information on OCS well control incidents was addressed in Section 1.1.4. It is recognized that the frequency for a VLOS on the OCS from a well control incident is very low. From 1971-2010 there has been one large/very large oil spill from a well control incident during exploratory and development/production operations on 41,781 OCS wells, or 2.39×10^{-5} per well.

A very large oil spill is a low-frequency event with the potential for very high effects. In this section and Table A.1-38 BOEMRE summarize the VLOS assumptions for purposes of analysis of the potential environmental impacts in the Beaufort and Chukchi Sea from the proposed action (USDOI, MMS, 2003; USDOI, BOEMRE, 2011b) and presents the analyses to listed species and critical habitat.

6.2. Beaufort Sea.

An analysis of a VLOS scenario was described in section IV.I of the Beaufort-Multiple Sale EIS (USDOI, MMS, 2003) and is summarized here. A well control incident resulting in a long duration flow was assumed to occur. . In estimating the oil spill flow rate, the scenario employs a hypothetical discharge using the highest producing wells on the Alaska North Slope at that time; a rate of 15,000 barrels of oil per day. Oil spill duration in the scenario is posited at 15 days, the State of Alaska standard at the time. The cumulative VLOS volume of 225,000 bbls was used to further consider weathering factors but not spill response in the analysis of the potential impacts. Computer model runs, simulating a blowout by S.L. Ross Environmental Research Ltd., Dickens and Associates, and Vaudrey and Associates (1998) estimate that 20% of the oil would evaporate in the air; this amount equals 45,000 barrels. An additional 3,400 barrels could remain on the gravel island (BPXA, 2000). A total of 176,600 barrels reaches the water or ice. For purposes of analysis, this number was rounded to 180,000 barrels. The estimated VLOS location was Launch Area (LA) 10 or 12 (USDOI, MMS, 2003: Tables IV.I-9a, 9b and 9c and Appendix A). In subsequent analysis LA 15 was determined to be statistically similar to LA12 (USDOI, MMS 2009a).

The BOEMRE reviewed the very large oil spill elements analyzed in the Beaufort Sea Multiple Sale EIS (summarized in A.1-39, column 2) to determine if the 2012 Shell Camden Bay Exploration Plan estimates are within the scope of the VLOS. BOEMRE determined that the low-probability, very large oil spill effects conclusions in the Beaufort Sea Multiple Sale EIS, Section IV.I remain valid for informing the decision maker of the effects of a low-probability, very large oil spill in the Beaufort Sea (USDOI, BOEMRE, 2011a). In addition to the original cleanup mitigation analyzed, the use of a capping stack and containment system could further limit the amount of oil reaching the sea surface and spreading should a loss of well control occur.

6.2.1.1. Polar Bear and Polar Bear Critical Habitat

Effects on polar bears and Polar Bear Critical Habitat

Polar bears inhabit the Beaufort Sea year round and are vulnerable to spills at any time of the year. Oil would remain highly toxic to polar bears even after the aromatic hydrocarbons have dissipated. In general, polar bears can be encountered throughout the ice covered waters of the Beaufort Sea. They are less likely to be found in open water, but will swim considerable distances from ice to shore or vice versa. As sea ice breaks up in spring, polar bears follow the receding ice edge and may come

ashore in late summer and fall, where they remain until the sea ice reforms in early winter. Large aggregations of polar bears may be vulnerable to a spill on Barter or Cross Islands in late summer and fall, when they congregate in these areas to feed on bowhead whale carcasses. Indirect sources of mortality may occur when seals or other mammals die from oil exposure. Bears have an excellent sense of smell and will travel long distances to locate food sources. Given that polar bears have been observed chewing on oil cans and fuel bladders, as well as snow machines and, in one case, a car battery; polar bears may not avoid prey items that are contaminated with oil. Ingesting oiled prey could be a secondary source of mortality from a spill.

Although there is a very low likelihood of a VLOS occurring, if it were to happen, a VLOS could contaminate a significant amount of coastal shoreline and the shoreline of barrier islands. Within 30 days of VLOS release under broken-ice conditions, about 20% (36,000 barrels) of the oil would contact coastline from about Pitt Point (Land Segment 31) east to about the Canning River Delta (Land Segment 43) (USDOI, MMS, 2003:Table IV.I-9c, LA12, 30 days). A portion of the ringed seal-pupping habitat in shorefast ice could at least partially be exposed to oil-spill contamination at the end of the pupping season in June, which would have impacts for polar bears hunting in this area. Prior to that time, most of the oil is expected to be encapsulated in the ice. After melt out of the oil spill in mid- to late June, the discontinuous area swept by the spill is expected to be 3,200 square kilometers.

About 67% of the VLOS likely would contact seal and polar bear ice-front habitats offshore from about Cape Halkett east to Mikkelsen Bay (represented by Ice/Sea Segments 3-5 or ERA's 31-33 [USDOI, MMS, 2003, Table IV.I-9b, LA10, 30 days]). Perhaps up to a maximum of 128 polar bears (assuming a very high bear density of 1 bear per 25 square kilometers and a total surface area of 3,200 square kilometers swept by the discontinuous oil slick from the 180,000-barrel oil spill) could be exposed to the oil spill (USDOI, MMS, 2003,Table IV.I-5). Assuming that all polar bears exposed to the oil died because of absorption (through the skin), inhalation, and/or ingestion of toxic hydrocarbons in the oil, this loss could be significant.

Conditional Probabilities

This section discusses the percent chance that a VLOS from the Beaufort Sea would contact polar bear Critical Habitat. Conditional probabilities assume that a spill has occurred. This analysis assumes that a spill could originate from the general area of Sivulliq and Camden Bay. A VLOS of 180,000 bbls occurring in open water would cover approximately 290 km² after 3 days and 5700 km² of discontinuous area after 30 days, and would oil an estimated 275-300 km of coastline. A spill during broken ice in the fall or under ice in the winter would melt out in the following summer, potentially causing major impacts to polar bear. A spill of the same size occurring in broken ice conditions would cover 160 km² after 3 days and 3200 km² of discontinuous area after 30 days, and would oil an estimated 100-130 km of coastline (Volume III of the Beaufort Sea MultiSale, 2003, Tables IV.I-5, 6b, and 8.)

After a VLOS, some oil would evaporate, disperse, become bound with sediment or come onshore. The amount of oil that would remain over time would vary depending upon the season in which the spill occurred. In open water or in broken ice in spring, 71,900 bbls would remain in a discontinuous slick after 30 days, while 73,900 Bbls would have evaporated. A spill into broken ice in fall would result in 120,900 Bbls remaining after 30 days and 59,000 bbls evaporating, with a discontinuous slick of 3200 km² after melt out in spring (Volume III of the Beaufort Sea MultiSale, 2003, Tables IV.I-4, 5, 6a, and 7.)

Barrier Islands and Coastline- Summer Oil Spills

A summer spill could impact polar bears coming ashore due to sea ice retreat, or in preparation for denning later in the fall/winter season. The areas that would be particularly important during this time period include barrier islands along the coast, as well as the coastline itself. The OSRA model estimates the chance of a summer oil spill contacting the barrier islands that are important resource areas to polar bears (Table IV.I-9a.) Barter Island and Cross Island are particularly important because

of the large concentrations of polar bears that are drawn to the islands to feed on bowhead whale carcasses in fall. A summer VLOS has a 4-9% chance or less of contacting Cross Island or No Name Island within 30 days. There is little difference within 360 days, the chance of contact remains 4-10%. A summer spill has a 1% chance or less of contacting Barter Island, Bernard Spit and Arey Island within 30 days. Within 360 days, the chance of contact remains at 1% or less. During summer the percent chance of a VLOS contacting any of the Beaufort Sea barrier islands ranges from <0.5% to 23% within 30 days, and varies from <0.5% to 26% (for Jones and Thetis Islands) within 360 days (Table IV.I-9a). If sea ice segments (ERAs 45-62) are considered, the chance of a summer spill contacting Ice/Sea segments varies from <0.5-55% within 30 days (IV.1-9a).

If land segments are considered, the chance of contact from a summer spill to the U.S. Beaufort Sea coastline within 30 days varies from 6% to 7% for Milne Pt., Simpson Lagoon area (Table IV.I-9c). The variation in chance of contact is due to the effects of wind, current ice, and proximity to shore. Within 360 days, the chance of contact varies from 5% to 8% for Milne Pt., Simpson Lagoon area and Oliktok Point (Table IV.I-9c). The chance that a VLOS would contact the shoreline of the Arctic National Wildlife Refuge, also an important polar bear denning habitat, within 30 days of a spill ranges from less than <0.5% to 3%. Within 360 days, this ranges from 3-11% (USDOI, MMS 2003, Table A2-87, 90).

Barrier Islands and Coastline- Winter Oil Spills

The OSRA model estimates the percent chance of a VLOS originating in winter contacting the barrier islands and coastline that are important resource areas to polar bears and that, together with sea ice, make up polar bear Critical Habitat. A VLOS in winter has a 2% chance or less of contacting Cross Island and No Name Island within 30 days, and a 2-6% chance of contact within 360 days, (Table IV.I-9b). A winter spill has a <0.5% chance of contacting Barter Island, Bernard Spit and Arey Island within 30 days, and a 1% or less chance of contact within 360 days. The percent chance of a VLOS contacting any of the Beaufort Sea barrier islands ranges from <0.5% to 3% in winter within 360 days, and varies from <0.5% to 20% (for Jones and Thetis Islands) within 360 days (Table IV.I-9b). If sea ice segments (ERAs 45-62) are considered, the chance of a summer spill contacting Ice/Sea segments varies from <0.5-51% within 30 days (IV.1-9b).

If land segments are considered, the chance of contact from a winter spill reaching the U.S. Beaufort Sea land segments within 30 days varies from <0.5% to 1% (Table IV.I-9b). The chance of contact from a winter spill reaching the U.S. Beaufort Sea land segments within 360 days varies from <0.5% to 9% near Cape Hallkett. The chance that an oil spill originating in winter would contact the shoreline of the Arctic National Wildlife Refuge within 30 days of a spill is < 0.5%. The chance that an oil spill would contact the shoreline of the Arctic National Wildlife Refuge within 360 days of a spill ranges from < 0.5% to 4% ((USDOI, MMS 2003, Table A2-81, 94).

Prey Reduction or Contamination

In the Beaufort Sea, ringed seals may make up as much as 98% of polar bear diet. Polar bear populations are known to decline or increase in relation to prey availability. In the past, numbers and productivity of polar bears have declined in response to declines in ringed seal populations in the Beaufort Sea (Schliebe et al, 2006). Large scale reductions or contamination of food sources (ringed and bearded seals) could reduce survival and reproductive success of the SBS and/or CS populations of polar bears. Small scale reductions in seal populations are less likely to impact polar bears because they tend to disperse over large areas in search of prey. However, polar bears are not likely to avoid oiled carcasses, and ingestion of oiled prey is likely to have lethal effects. Oritsland et al found that ingestion of petroleum hydrocarbons lead to anorexia and damage to kidneys, liver, and other tissues. The effects of the damage were not apparent for several weeks after ingestion.

Prevention and Response

Oil spill responses (clean up efforts) vary from highly effective in calm open water conditions to largely ineffective during unfavorable or broken-ice conditions. BOEMRE requires that each

operator have an approved Oil Spill Response Plan prior to the onset of production, and that equipment and trained personnel be available to respond to spills.

In general, oil spill response activities include containing the release and spread of oil, recovering oil as quickly as is safely possible, and keeping oil away from areas identified as critical habitat using boom or other resources. Both Cross and Barter Island have been identified in spill response documents and on maps as critical habitat for polar bear (Alaska Clean Seas Technical Manual, 2007). FWS is currently in the process of updating oil spill response plans with regard to the designation of polar bear critical habitat. During oil spill response activities, oiled carcasses would be collected when feasible, which could lessen the risk of polar bears ingesting oiled prey items. In some circumstances, such as oiled seals or seal carcasses floating in broken ice and in open leads, it would be very difficult to locate and recover carcasses.

Depending upon the location of the spill, oil spill response could take some time to begin. Oil spill response equipment is cached in Barrow, and in Deadhorse, about 150 mi east of Barrow. Hazing may be very effective in the case of small spills or in relatively discrete areas. Oil spill response personnel would be expected to work with the FWS on polar bear management activities in the event of a spill. Wildlife response activities could involve hazing bears away from an area, however once oiled, a polar bear may not survive.

Summary

Increasing trends in polar bear use of terrestrial habitat in the fall are likely to continue, as sea ice conditions continue to change. Although the frequency of a VLOS occurring in the OCS is very low, should such a spill occur it could result in a high level of risk to polar bear aggregations and therefore to the polar bear population as a whole. If such an event were to occur in offshore waters, it could result in significant impacts to the polar bear population. Shoreline, barrier islands or sea ice that becomes contaminated with oil would no longer provide safe resting or foraging habitat for polar bears. Clean up activities and hazing could keep bears away from contaminated shorelines or barrier islands, however preventing bears from accessing oiled sea ice would be extremely difficult.

6.2.1.2. Threatened and Endangered Birds

This section describes the analysis of a VLOS in the Beaufort Sea for spectacled and steller's eiders, Kittlitz's murrelets and yellow-billed loons.

Effects on Spectacled and Steller's Eiders. From early June to early July (males) and late June to early September (failed females or females with young), flocks of spectacled eiders may be present in coastal lagoons and offshore waters (Fischer, Tiplady, and Larned, 2002; TERA, 1995, 1999); in late summer females with fledged young move from coastal habitats to nearshore or offshore areas. Realistic values for densities of spectacled eiders present in these areas that would allow the estimation of potential mortality from oil- spill contact are unavailable. However, in the unlikely event of a 180,000-barrel spill covering a discontinuous area of 5,700 square kilometers after 30 days (Table IV.I-8, USDO, MMS, 2003), some of these flocks, or females with young along the 275-300 kilometers (100-130 miles [Table IV.I-6, USDO, MMS, 2003]) of coast (maximum distance is equivalent approximately to the coastline from Camden Bay to western Harrison Bay) where oil is likely to contact or become stranded, are expected to be contacted and may experience substantial mortality. A spill occurring in winter and released from the ice in spring could contact eiders in open water near river deltas. For the spectacled eider, with a relatively small regional population and low productivity, the loss that could result from such a spill of perhaps tens of locally nesting individuals plus an unknown number of migrants would represent a significant loss. Because there is no clear population trend in the coastal plain population, and there is a lack of certain data required to model population fluctuations, an estimate of recovery time from such a loss currently would be speculative. Also, losses may be difficult to separate from natural variation in population numbers (see the discussion in Section IV.C.5.b(1)(b)3, USDO, MMS, 2003). If a VLOS occurred in August or

September, there is a potential for small numbers of Steller's eiders that nest on the western Arctic Coastal Plain to be contacted while staging in the western Beaufort Sea. This could represent a substantial proportion of the coastal plain population.

Oil contacting or mixed into bottom sediments and mudflat areas (an estimated 4,100 barrels [Table IV.I-4, USDO, MMS, 2003]), or affecting species-rich foraging areas such as boulder patches, is expected to kill substantial numbers of eider food organisms. It is difficult to determine the actual effect that such indirect effects as a decline in food organisms would have on bird populations. Decreased food availability might adversely affect the ability of juvenile birds to develop as rapidly as they would normally, decrease adult fitness, or might delay the accumulation of fat reserves for migration. Any mortality from such indirect effects would be additive to the loss of oiled individuals.

Prevention and Response During Open-Water Conditions. Despite the potential for effective spill containment, recovery, and cleanup under ideal weather conditions, these may not exist during a spill incident, and some eider habitats are likely to be contacted by oil. Most detections of satellite-tagged spectacled eiders were in or offshore of Simpson Lagoon and west. The OSRA model estimates the chance of contact by spilled oil within 30 days in summer in nearshore or offshore areas ranges up to 55%; along the shoreline contact probability is less than 8% (Tables IV.I-9a and IV.I-9c, USDO, MMS, 2003). These areas would need to be surveyed for eider presence to plan an adequate response strategy. If the spill is not contained before reaching these areas, the most effective response may involve hazing. The probability of a very large oil spill occurring is extremely small.

Although spectacled eiders apparently spend little time in nearshore coastal habitats, females with broods may occupy them briefly before moving to offshore staging areas. Containment, recovery, and cleanup activities for a very large oil spill are expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. The presence of such a workforce is likely to act as a general hazing factor, displacing any eiders from the immediate area of activity, perhaps within a few kilometers, which potentially might be viewed as a positive result, given birds' extreme vulnerability to oil in the environment. If a reliable system of locating eiders in a specific area can be devised, specific birds or groups in danger of oil contact could be targeted with specific hazing tactics.

Currently, no important specific foraging areas for eiders are identified, although numerous satellite transmitter locations and visual observations during aerial surveys suggest that in and offshore of Harrison Bay may be an important area. Because spectacled eiders nest at low density, and there appears to be little tendency for them to nest near the coast (Troy Ecological Research Assocs., 1999), disturbance of nesting eiders by onshore cleanup activities is not expected to result in significant increases in nest abandonment or loss of eggs or young to predators or exposure to weather, or overall decreases in productivity. Displacement by cleanup activity of females with broods from coastal habitats may have a negative effect, if it prematurely forces them into the offshore marine environment where the high salinity could increase stress on the ducklings, which have a relatively low tolerance to salt. Helicopter support traffic and human presence probably would be the most disturbing factors associated with oil-spill-cleanup activity. If their presence forces eiders from a marine area where oil contact is imminent, it may be considered a positive factor. However, overland flights and off-road personnel activity during the nesting season may displace females from their nests or broods and result in egg or duckling losses from predation or exposure.

Prompt containment and removal of oil from offshore areas, accompanied by hazing tactics targeting high-use areas, is likely to result in a substantial reduction of spectacled eider mortality from a very large oil spill. Cleanup also would decrease the amount of oil available for uptake by bottom-dwelling organisms that are the principal food of eiders. This could reduce the potential for oil uptake by eiders and associated adverse physiological side effects, although the benefit of this indirect effect on the eider population cannot be quantified at present.

Prevention and response during Broken-Ice Conditions. Containment and oil recovery following a blowout spill that enters the marine environment under broken-ice conditions at meltout or freezeup is expected to be less effective than for an open-water spill. Although under these conditions the area

covered by the spill would be smaller than a spill in open water (3,200 versus 5,700 square kilometers [Tables IV.I-5 and IV.I-8]), spectacled eiders are not expected to occupy broken ice in either period, unless areas of open water are available. Many arriving spring migrants likely would occupy open overflow areas off river mouths that are available early and are in the vicinity of nesting areas; the greatest benefit of spill cleanup may result from containment and cleanup in such areas. In this season, the hazing effect of cleanup activity or actively hazing birds out of areas that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy.

If most spectacled eiders arrived in the area via overland routes (TERA, 1999), the benefit of spill containment and cleanup would be minimal until they reenter the marine environment following the breeding period. By this time, the oil would have weathered and likely have become a decreased hazard for plumage fouling. Indirect adverse effects resulting from the intake of contaminated prey organisms may be higher under broken-ice than open-water conditions, because reduced cleanup capability would provide a longer interval for exposure and uptake by such organisms. Entrapment of large quantities of oil in coastal marsh and adjacent habitats could present a hazard to departing males following breeding and females with young following nesting as they move to offshore waters. In fall, spectacled eiders are not likely to be present in substantial numbers beyond late September, and oil present in broken ice at this time likely would not contact eiders.

Conclusions for Spectacled and Steller's Eiders. The 180,000-barrel blowout oil spill in open water assumed for this analysis is expected to cause spectacled eider mortality, if females with recently fledged young contact stranded oil in coastal habitats, or flocks of adult eiders or females with young feeding in lagoons and offshore waters are contacted by a spill sweeping over thousands of square kilometers. A winter spill released from the ice in spring could contact eiders concentrated in open water of river deltas. Substantial mortality that could result from a very large oil spill would represent a significant loss for the relatively small Arctic Coastal Plain spectacled eider population, requiring many generations for recovery. Recovery is not likely to occur while the regional population is in declining status. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the loss of oiled individuals. Although FWS survey data do not show a significant decline in the coastal plain spectacled eider population, the potential exists for a significant adverse effect from an oil spill on this regional population. Mortality of a few Steller's eiders also could represent a substantial loss to its small regional population.

Kittlitz's murrelet and Yellow-billed Loon. A VLOS occurring in winter and released in spring could contact yellow-billed loons and Kittlitz's murrelets in open water near river deltas. For species such as yellow-billed loons, with relatively small populations and low productivity, this could represent a major level of effect.

Prevention and response during Open-Water Conditions. Despite the potential for effective spill containment, recovery, and cleanup under ideal weather conditions, these may not exist during a spill incident and some loon and murrelet habitats are likely to be contacted by oil. Aerial surveys (Fischer, Tiplady, and Larned, 2002; Larned et al., 2001) recorded substantial numbers of loons, waterfowl, and seabirds from Mikkelsen Bay west to Harrison Bay and Point Barrow. In this area, the Oil-Spill-Risk Analysis model estimates that the probability of contact by spilled oil in 30 days in summer in nearshore or offshore areas ranges up to 55%; along the shoreline, the probability of contact is less than 8% (Tables IV.I-9a and IV.I-9c, USDOI, MMS, 2003). Although some species exhibited concentrations in Harrison Bay and Simpson and other lagoons, as a group, this suite of species was surprisingly widespread in its offshore distribution, ranging from the coastal shoreline to 50 kilometers offshore. If a very large oil spill is not contained before reaching these areas, the most effective response may involve hazing. The probability of a very large oil spill occurring is extremely small.

Containment, recovery, and cleanup activities for a very large oil spill are expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. The presence of such a workforce is likely to act as a general hazing factor, Very Large Oil Spills

displacing birds from the immediate area of activity, perhaps within a few kilometers, which potentially may be viewed as a positive result given the extreme vulnerability of birds to oil in the environment. If a reliable system of locating bird concentrations in a specific area can be devised, specific birds or groups in danger of oil contact could be targeted with specific hazing tactics.

Displacement of female waterfowl with broods from coastal habitats by cleanup activity may have a negative effect if it prematurely forces them into the offshore marine environment where foraging may be more difficult for the ducklings, and other stresses may increase. Disturbance of nesting sea ducks by onshore cleanup activities is not expected to significantly affect their productivity. There appears to be little tendency for most of these species to nest near the coast, where there is the highest probability of disturbance by cleanup activity. Because of low nesting density, few nesting birds are likely to be displaced and potentially lose their clutches or broods to predators or exposure to weather as a result of disturbance by cleanup operations. Helicopter support traffic and human presence probably would be the most disturbing factors associated with oil-spill-cleanup activity. If their presence forces loons or murrelets from a marine area where oil contact is imminent, it may be considered a positive factor.

Prompt containment and removal of oil from offshore areas, accompanied by hazing tactics targeting high-use areas, is likely to result in a substantial reduction of mortality to listed birds from a VLOS.

Prevention and response during Broken-Ice Conditions. Containment and oil recovery following a blowout spill that enters the marine environment under broken-ice conditions at meltout or freezeup is expected to be less effective than for an open-water spill. Although under these conditions the area covered by the spill would be smaller than a spill in open water (3,200 versus 5,700 square kilometers [Tables IV.I-5 and IV.I-8, USDOl, MMS, 2003]), some bird species are not expected to occupy broken ice in either period unless areas of open water are available. Even after spring melting provides areas of open water, most arriving spring migrants likely would occupy overflow areas off river mouths, because those are available earlier and are in the vicinity of nesting areas. The greatest benefits may result from containment and cleanup in such areas. In this season, the hazing effect of cleanup activity or actively hazing birds out of areas that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy. For sea ducks arriving via overland routes, the benefit of spill containment and cleanup would be minimal until they begin reentering the marine environment following breeding. By this time, the oil would have weathered and is expected to have become a decreasing plumage-fouling hazard. Indirect adverse effects resulting from intake of contaminated prey organisms may be higher under broken-ice than open-water conditions, because reduced cleanup capability would provide a longer interval for exposure and uptake by such organisms. Entrapment of large quantities of oil in coastal marsh and adjacent habitats could present a hazard to departing males following breeding and females with young following nesting as they move to offshore waters. In fall, beyond late September, most sea ducks and other birds are not likely to be present in great numbers, and oil present in broken ice at this time may have weathered and become less of a plumage-fouling hazard.

Conclusion for Kittlitz's Murrelet and Yellow-billed Loon. A 180,000-barrel oil spill in open water assumed for this analysis is expected to result in the loss of Kittlitz's murrelets and yellow-billed loons if they contact stranded oil along a substantial proportion of nearshore coastal areas. A winter spill entering the environment after the ice melts in the spring could contact yellow-billed loons in open water near river deltas. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the losses of oiled individuals.

Losses resulting from any aspect of development may be difficult to separate from natural variation in population numbers (see the discussion in Section IV.C.5.b(1)(b)3, USDOl, MMS, 2003).

6.3. Chukchi Sea:

This section summarizes the VLOS scenario in section IV.D of the Sale 193 Final SEIS (USDOl, BOEMRE, 2011b). A well control incident resulting in a long duration flow was assumed to occur. In

estimating the oil spill flow rate, the scenario employs a hypothetical discharge model that estimates the highest possible uncontrolled flow rate that could occur from known prospects in the Sale 193 area, given real world constraints. Oil spill duration in the scenario is posited at 74 days, the estimated length of time required for a second drilling platform to arrive on scene from elsewhere in the Pacific Ocean, and then complete a relief well

The oil discharge climbs rapidly to over 61,000 bbls/day during Day 1 falling to 20,479 bbls/day by Day 74. The total oil discharge by the end of the flow period on Day 74 is 2,160,200 bbls. The cumulative VLOS volume of 2.2 MMbbls (million barrels) was used to further consider weathering factors but not spill response in the analysis of the potential impacts. Launch Areas (LAs) 1 through 13 are the areas where a VLOS could originate from a well control incident (USDOl, BOEMRE, 2011b, Appendix B, Tables B-7-29).

On May 12, 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) received from Shell Gulf of Mexico Inc. (Shell) a Revised Exploration Plan (EP) and associated Revised Oil Discharge Prevention and Contingency Plan in support of a proposed 2012 and beyond exploration drilling program on its Chukchi Sea Outer Continental Shelf leases. On August 19, 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) received from ConocoPhillips, Inc. an Exploration Plan (EP) and associated Oil Discharge Prevention and Contingency Plan in support of a proposed 2013 and beyond exploration drilling program on its Chukchi Sea Outer Continental Shelf leases.

Activities involving Chukchi Sea leases acquired by Lease Sale 193 are restricted because of a remand issued by the Federal Court for the Alaska District on July 21, 2010. BOEMRE therefore cannot approve any EPs in the Chukchi at this time, and is treating the Chukchi EPs as drafts.

The Bureau will not take any official action on the draft EP unless the Secretary of the Interior chooses to reaffirm Chukchi Sea Lease Sale 193. The U.S. District Court for the District of Alaska has instructed the Department of the Interior to file this decision with the court by October 3, 2011.

These draft EPs have been posted on BOEMRE's website for information purposes only and the information is used for purposes of analysis only for preliminary WCD estimates. The current estimated WCD estimates by Shell Gulf of Mexico Inc. and Conoco Phillips Inc. do not exceed the VLOS volumes analyzed in USDOl, BOEMRE (2011b). Based on these initial WCD estimates the very large oil spill effects conclusions in the USDOl, BOEMRE (2011b) remain valid for informing the decision maker of the effects of a, low-probability, very large oil spill in the Chukchi Sea. In addition to the original cleanup mitigation analyzed, the use of a capping stack and containment system could limit further the amount of oil reaching the sea surface and spreading should a loss of well control occur.

6.3.1.1. Polar Bear

A very large oil spill (VLOS) from a well blowout during exploration or development and production is considered a highly unlikely event and is not reasonably certain to occur. This hypothetical scenario describes the potential effects of a very large oil spill associated with a well-control incident in the Chukchi Sea. While not a part of the Proposed Action, the potential effects are described here. The impacts that occur during each phase of a blowout and subsequent clean up are discussed below. The most direct impacts would occur as a result of Phases 2 and 3, which entail an offshore oil spill and onshore contact.

Phase 1 (Initial Blowout Event)

The initial phase would likely consist of a large explosion of natural gas and a fire. The rig may or may not be disabled or sink at that point. The impact producing factors that might effect polar bears would be the explosion itself (depending upon the size of the explosion) and the smoke and debris resulting from the fire. As drilling would occur during the open water season, polar bears are not likely to be in the area when the explosion occurs. Polar bears are known to swim long distances between shore and sea ice (Schliebe et al., 2008; Gleason and Rode, 2009), but would likely avoid the noise and activity associated with drilling (Anderson and Aars, 2008).

Phase 2 (Offshore Oil Spill)

Polar bears rely on their fur and a subcutaneous layer of fat for insulation and any oiling would cause the fur to lose its insulating ability. Hurst and Oritsland found that polar bear pelts were similar to those of sea otters and fur seals in terms of the loss of insulation once oiled (Hurst and Oritsland, 1982). Once oiled, polar bears could ingest oil while grooming. Exposure to oil or associated fumes could cause respiratory distress and inflammation of mucous membranes and eyes, leading to damage such as abrasions and ulcerations. High levels of exposure would likely result in death. Chronic low levels of exposure may result in long term sub-lethal effects that reduce fitness. Oiling could lead to hypothermia and result in increased energetic costs or death. Polar bears could also ingest oil by eating oiled seals or carcasses, which could lead to impacts to kidney or liver function.

Polar bears rely primarily on ringed and bearded seals as prey in the Chukchi Sea, but they will also take beluga and walrus. Polar bears will scavenge marine mammal carcasses when available, and do not show an aversion to petroleum products. Polar bears have been observed biting cans of snowmobile oil and neoprene bladders of fuel. One polar bear died as the result of eating a car battery, while another died after ingesting ethylene glycol (Geraci and St. Aubin, 1990; Amstrup et al 1989). Polar bears scavenging on oiled seal carcasses could ingest lethal doses of oil. Studies on seal species have indicated that seals intent on feeding will not avoid an area due to oil or oil sheens (Geraci and St. Aubin, 1990). Polar bears may pursue seals in oiled waters. Ringed and Bearded seals have the ability to metabolize small amounts of hydrocarbons so that such tissue damage is temporary unless the exposure is chronic over time (Kooyman, Gentry and McAlister, 1976). Long term or chronic oil ingestion may result in kidney damage, liver damage, or ulcers in the digestive tracts of seals and the polar bears that feed upon them.

Phase 3 (Onshore Contact)

Depending upon the location of the spill site and other factors, BOEMRE has estimated that oil could contact shore within 10 days. Polar bears could come into contact with oil as they move along the coast or barrier islands, or while moving between shore and the ice edge. Regardless of whether contact occurred at sea, on ice or on land, the results to the physical health of the polar bear would be the same as those listed under Phase 2. If polar bears avoid coastal areas that have been fouled by oil, they may be excluded from important resting or denning areas, which may impact fitness or breeding success.

Oil Spill Trajectory Analysis

A VLOS could contact offshore or onshore areas where polar bears may be present. The degree of contact with oil would depend upon the location, timing, and magnitude of the spill. The OSRA model divides the 193 lease sale area into 13 launch areas (LAs) to model the spill trajectories from different sources of origin. The LAs are found in USDOI, BOEMRE, 2011b, Appendix B, Figure B-10. In many instances, the differences between launch areas are less important than the magnitude of the spill given the large area that a VLOS could encompass.

The drilling season in the Chukchi Sea is the open water season, typically between July 15 and October 31. The time period for stopping the spill with a relief well ranges from 39 to 74 days. BOEMRE estimates that spilled oil could remain on the surface of the water for up to 3 weeks. A spill beginning early in the open water season and stopped within 39 days would therefore persist for 60 days. A spill which started late in the open water season or was not stopped for 74 days would likely freeze into the ice and persist over winter, melting out in the spring. BOEMRE, therefore, analyzed a summer spill that persists for 60 days and 360 days, and a winter spill that persists for 360 days.

This section describes the results estimated by the Oil Spill Risk Analysis (OSRA) model of a hypothetical very large oil spill in the Chukchi Sea contacting specific Environmental Resource Areas (ERAs), Land Segments (LSs) or Grouped Land Segments (GLSs) where polar bears may be found. With the exceptions of Cross Island, Barter Island and Wrangel Island, CBS and SBS polar bears are not usually found in large aggregations. Reductions in sea ice may be resulting in more bears coming ashore and in individual bears spending more time on shore during the fall open water season

(Schliebe et al, 2008). Both ringed seal distribution and ice conditions affect polar bear densities. Polar bear populations have been observed to increase or decline as seal populations increase or decline (Stirling, 2002). Polar bears hunt ringed seals in spring leads, pack ice, and at their breathing holes. In spring, polar bears preferentially hunt pups in lairs (Stirling and Archibald, 1977). In addition to areas where polar bears concentrate while waiting to den or for the sea ice to freeze (Wrangel Island, Barter Island and Cross Island, and to a lesser extent Kolyuchin Island, and the Pt. Barrow area), this analysis is focused on the Chukchi and Beaufort sea spring lead systems, and on near shore ice in the Beaufort Sea. The estimated percentage of trajectories contacting the Russian, Chukchi or Beaufort Sea coastlines in the event of a very large oil spill have also been analyzed. A VLOS that occurred during the summer open water period or during the fall broken ice period is likely to have the greatest impact on polar bears (Amstrup et al, 2006).

An Environmental Resource Area (ERA) is a polygon that represents a geographic area during a specific time period. The ERA locations are incorporated from USDOI, MMS (2007a) and found in USDOI, BOEMRE, 2011b, Appendix B, Figures B-2 to B-5. The ERAs are summarized in USDOI, MMS, 2007, Appendix A, Tables A.1–13 through A.1–15 of the Lease Sale 193 EIS. The vulnerability of an ERA is based on the seasonal use patterns of polar bears (USDOI, MMS, 2007a, Appendix A, Table A.1–12). LS and GLS are sections of the coastline and are not seasonal. For this analysis, BOEMRE does not consider the effectiveness of clean up methods. BOEMRE makes the assumption that if oil contacts the coastline, the oil will remain there.

In the Sale 193 FEIS, the OSRA analysis focused on Wrangel Island, Kolyuchin Island, the Russian coastline of the Chukchi Sea and the Barrow area. Since that time, there have been changes in polar bear distribution related to sea ice loss. Polar bear critical habitat has also been established which includes the U. S. Chukchi Sea coastline and offshore barrier islands. Additional ERAs and GLSs from the original EIS that were not used in relation to polar bears at that time are included here to capture this new information about where polar bears may come into contact with oil. Where possible, ERAs have been used with a year round vulnerability (Jan-Dec). In the event that oil was to contact these ERAs in December through February, it would freeze into the ice and snow over winter and remain frozen in the ice until spring. The oil would then melt out of the thawing ice in the spring.

The additional ERAs and GLSs that BOEMRE has analyzed in this VLOS analysis all occur on the U. S. side of the Chukchi Sea. The full list of ERAs and GLSs analyzed are in Table 2.

Summer Spills (June 1 – October 31)

The following information is summarized from USDOI, BOEMRE, (2011b) Tables B-7, B-8, B-11, and B-12. A summer spill is defined as a spill taking place during the open water season between June 1 and October 31. The OSRA model estimates that 2% or fewer of the trajectories launched during this time period would contact Wrangel Island or Kolyuchin Island within 60 days or within 360 days. The OSRA model estimates that 4% or fewer of the trajectories would contact any section of the Russian coastline in 60 days with one exception, from LA9 12% of the trajectories would contact some section of the Russian coastline, though not necessarily where polar bears may be. Over 360 days, the percentage of trajectories that would contact some section of the Russian coastline is 6% or fewer, again with the exception of LA9 where the percentage of trajectories contacting the coastline would be 19%.

Table 2 Polar bear habitat areas analyzed in the Chukchi Sea VLOS OSRA analysis

ERA or GLS	Geographic Description	Period of Vulnerability	Figure in Appendix B, USDOI, BOEMRE, 2011b,
ERA 2	Pt Barrow, Plover Islands area	May-Oct	B-2
ERA 8	Maguire and Flaxman Islands	May-October	B-4
ERA 11	Wrangel Island with 12 mile buffer	Jan - Dec	B-2
ERA 20	Southern portion of Chukchi spring lead system	April-June	B-3
ERA 21	Middle portion of Chukchi spring lead system	April-June	B-3
ERA 22	Northern portion of Chukchi spring lead system	April-June	B-3

ERA or GLS	Geographic Description	Period of Vulnerability	Figure in Appendix B, USDOT, BOEMRE, 2011b,
ERAs 24-28	Beaufort Sea spring lead system	April-June	B-3
ERAs 29-34	Beaufort Sea nearshore ice	Sept-Oct	B-4
ERA 43	Nuiqsut subsistence area / Cross Island	Aug-Oct	B-5
ERA 44	Kaktovik subsistence area/ Barter Island	Aug-Oct	B-4
ERA 59	Kolyuchin Island	May - Nov	B-2
ERA 69	Harrison Bay / Colville Delta	May-Oct	B-3
ERA 71	Simpson Lagoon, Thetis and Joe's Islands	May - Oct	B-4
ERA 72	Gwyder Bay, Cottle Return Islands and West Dock	May - Oct	B-4
GLS 95	Russian coastline, LSs 1-39	Jan-Dec	B-9
GLS 96	US Chukchi Sea coastline, LSs 40-84	Jan-Dec	B-9
GLS 97	US Beaufort Sea coastline, LSs85-111	Jan-Dec	B-9

On the U. S. side of the Chukchi Sea, results are more variable. The percentage of trajectories contacting the Pt. Barrow/Plover Islands area within 60 days is 2% or less from all launch areas except LA8 (9%) and LA13 (8%). Within 360 days, the percentage of trajectories contacting this area is 2% or fewer from all LAs except LA7 (6%), LA8 (13%) and LA13 (10%). For the Chukchi Sea spring lead system, 3% or fewer of the trajectories would contact the spring lead system within 60 days. Within 360 days, 4% or fewer trajectories will contact the Chukchi Sea spring lead system. The highest percentage of trajectories contacting the spring lead system are from LAs 10, 11 and 12. Fewer than 1% of trajectories from any LA would contact the Beaufort Sea spring lead system within 60 days. Within 360 days fewer than 6% of trajectories would contact any portion of the Beaufort Sea spring lead system. BOEMRE also analyzed the percentage of trajectories that would contact nearshore sea ice in the Beaufort Sea, 1% or fewer trajectories would contact any portion of the nearshore ice within 60 days, with the exception of spills originating in LA8 (1-5%) and LA13 (0.5-5%). Over 360 days, fewer than 1% of trajectories would contact the sea ice nearshore with the exceptions of spills originating in LA7 or LA8 (2-6%) and LA13 (0.5-6%). Over 60 days, <0.5% of trajectories would reach the Harrison Bay/ Colville Delta area. This rises to 1% for LA8 and LA13 over 360 days.

Over 60 or 360 days, <0.5% of trajectories reach Maguire, Flaxman, Cross, or Barter Islands. Over 60 or 360 days, <0.5% of trajectories reach Simpson Lagoon, Thetis or Joe's Islands, Gwyder Bay, Cottle or Return Islands.

Over 60 days, 1% of trajectories from LA1, LA2, or LA3 reach the U.S. Chukchi Sea coastline; 4-6% from LA4, LA6, LA7, or LA8; 9% from LA5 or LA9; 17-26% from LA10, LA11, LA12 and LA13. Over 360 days, 1-3% of trajectories from LA1, LA2, or LA3 reach the U.S. Chukchi Sea coastline; 6-11% from LA4, LA5, LA6, LA7, LA8 or LA9; 20-31% from LA10, LA11, LA12 and LA13. Over 60 days, fewer than 0.5-1% of trajectories from LAs 1-6 or from LAs 9-12 reach the U.S. Beaufort Sea coastline; 4% from LA7, 14% from LA8; and 15% from LA13. Over 360 days, <0.5-3% of trajectories from LAs 1-6 and LAs and LAs 9-12 reach the U.S. Beaufort Sea coastline; 7% from LA7, 20% from LA8 and 19% from LA13.

Winter Spills (November 1 – May 31)

The following information is summarized from USDOT, BOEMRE, (2011b) Tables B-16, B-19, and B-20. A winter spill is defined as a spill taking place between November 1 and May 31, in other words, the trajectories would be launched during this time period. For a winter spill, BOEMRE has only considered the full 360 day period. The OSRA model estimates that 4% or fewer of the trajectories launched during this time period would contact Wrangel Island or Kolyuchin Island within 360 days. The OSRA model estimates that 5% or fewer of the trajectories would contact any section of the Russian coastline in 360 days with the following exceptions: LA1 (6%), LA4 (12%), and LA9 (32%).

For the U. S. side of the Chukchi Sea, 6% or fewer of the trajectories from any LA would contact the Pt. Barrow/ Plover Islands area within 360 days. For the Chukchi Sea spring lead system, fewer than 6% of the trajectories would contact the spring lead system over 360 days with the following exceptions: LA10 (7-10%), LA11 (3-12%), LA12 (1-14%). For the Beaufort Sea spring lead system, fewer than 5% of trajectories from any LA would contact the lead system ERAs. For the Beaufort Sea near shore ice ERAs, fewer than 1% of trajectories would contact these ERAs. For the Harrison Bay/Colville Delta ERA, <0.5% of trajectories would contact this ERA except from LA8 where 1% of trajectories would contact some part of the Harrison Bay/ Colville Delta ERA. The OSRA model estimates <0.5% of trajectories originating from any LA would contact ERAs 8, 33, 34, 43, 44, 71, or 72.

Over 360 days, fewer than 2% of trajectories would contact any portion of the Russian Chukchi Sea coastline with the following exceptions: LA1 (6%), LA4 (12%), LA9 (32%) and LA10 5%. Over 360 days, fewer than 5% of trajectories would contact any portion of the U. S. Chukchi Sea coastline with the following exceptions: LA4 (8%), LA5 (12%), LA10 (28%), LA11 (21%), LA12 (20%), and LA13 (9%). Over 360 days, fewer than 5% of trajectories would contact any portion of the U. S. Beaufort Sea coastline with the following exceptions: LA7 (6%), LA8 (9%), LA12 (6%), and LA13 (10%).

Conclusion

In the event of a VLOS in this scenario, most of the contact between oil and polar bear habitat would occur on the U.S. side of the Chukchi Sea. The majority of the CBS stock is believed to den and come ashore on the Russian side of the Chukchi Sea, particularly at Wrangel Island. The majority of the SBS stock of polar bears come ashore and den further eastward in the Beaufort Sea. However there is a large area of overlap between the CBS stock and the SBS stock out on the sea ice in the northeastern portion of the Chukchi Sea. Both stocks are believed to be in decline. If a VLOS were to occur and if it resulted in the loss of large numbers of polar bears, particularly adult breeding age females, this would have a significant impact on the SBS and/or CBS stocks of polar bears. Contact with oil on the U.S. side of the Chukchi Sea would be most likely to occur along the U.S. Chukchi Sea coastline or the U.S. Chukchi Sea barrier islands. In the event of a VLOS, key habitats to protect for polar bears would include the barrier islands and shoreline. The largest percentages of trajectories contacting sensitive habitats originate from the launch areas nearest to shore, LAs 9-13 (USDOI, BOEMRE, 2011b, Appendix B, Figure B-10). Therefore the most protection to resources is afforded by the broadest coastal deferral, Alternative III. This alternative offers the most protection to nearshore resources, spring lead systems and spring polynyas because it decreases the percentage of trajectories that would contact these resource areas. It also affords more time prior to contact for clean up workers to effect as much clean up as is possible before the oil begins to contact nearshore resources.

6.3.1.2. Threatened and Endangered Birds

No very large oil spills are estimated from exploration activities. A very large oil spill (VLOS) from a well blowout during exploration is considered a highly unlikely event and is not reasonably certain to occur. A hypothetical VLOS scenario for the Chukchi Sea was described in the Sale 193 Final SEIS (USDOI, BOEMRE, 2011b). The hypothetical scenario describes the potential effects of a very large oil spill associated with a well-control incident in the Chukchi Sea. While not a part of the Proposed Action, the effects of this low-probability event are indicative of the level of effect such an event could have in the Arctic Region OCS.

A hypothetical VLOS could contact offshore areas when and where listed species may be present. The location, timing and magnitude of a VLOS and the concurrent seasonal distribution and movement of listed birds would determine whether or not contact with the oil occurs. The Oil Spill Risk Analysis (OSRA) modeled oil spill trajectories from 13 launch areas (LAs) (Table A.1-15, Appendix A, USDOI, MMS, 2007).

This section describes the results estimated by the OSRA model for a hypothetical VLOS originating within 13 LAs in the Chukchi Sea Planning Area contacting specific Environmental Resource Areas (ERAs). The ERAs noted in this section are spatial representations (polygons) that indicate a

geographic area important to listed birds (Table A.1-15, Appendix A, USDOl, MMS, 2007). For the purpose of this analysis, the hypothetical initial well control incident could occur any time between July 15 and October 31 and represents a “summer spill.” A 60 day contact period for a summer open water season spill considers that a spill could persist on the sea surface for up to three weeks before it has dissipated. Oil could continue to spill after October 31 and spilled oil could freeze into the newly forming ice, remain encapsulated in ice throughout the winter and be released as the ice warms and thaws in the spring; therefore, continued spillage of oil after October 31 is considered a “winter spill” with a conservative spilled oil contact period of 360 days. To complete a relief well would take between 39 and 74 days (Figure 13). Fresh oil contributed to the marine environment after October 31 would be considered a “winter spill.” The effectiveness of oil spill response activities is not factored into the results of the OSRA model.

Figure 13 illustrates the sequence of events that would occur following a loss of well control event. The time scale on the left side indicates elapsed time from the initial loss of well control.

The OSRA model estimated the percent of trajectories from a hypothetical VLOS contacting ERAs important to listed birds. The dynamics of oceanographic, climatic, and biotic factors affecting the distribution and abundance of prey, timing of accessibility to habitats, and corridors for movement determine the opportunity for listed birds and oil to come into contact.

The full VLOS analysis for the Chukchi Sea is described in the Sale 193 Final SEIS (USDOl, BOEMRE, 2011b). The following discussion presents the results estimated by the OSRA model of the hypothetical VLOS contacting ERAs important to listed birds. The dynamics of oceanographic, climatic, and biotic factors affecting the distribution and abundance of prey, timing of accessibility to habitats, and corridors for movement determine the opportunity for listed birds and oil to come into contact. There are situations where large flocks of listed birds can contact oil. Trajectory contact with an ERA does not indicate the entire ERA is oiled, only that it is contacted somewhere.

A very large oil spill (VLOS) could affect large numbers of listed birds due to the fact that they spend so much time on the surface of offshore and nearshore waters. Direct contact is the primary way that oil could kill birds in part due to its toxicity to individuals and their prey. The biology and status of marine and coastal birds are described in Section 3, and is also described in the Sale 193 Final SEIS (USDOl, BOEMRE, 2011b).

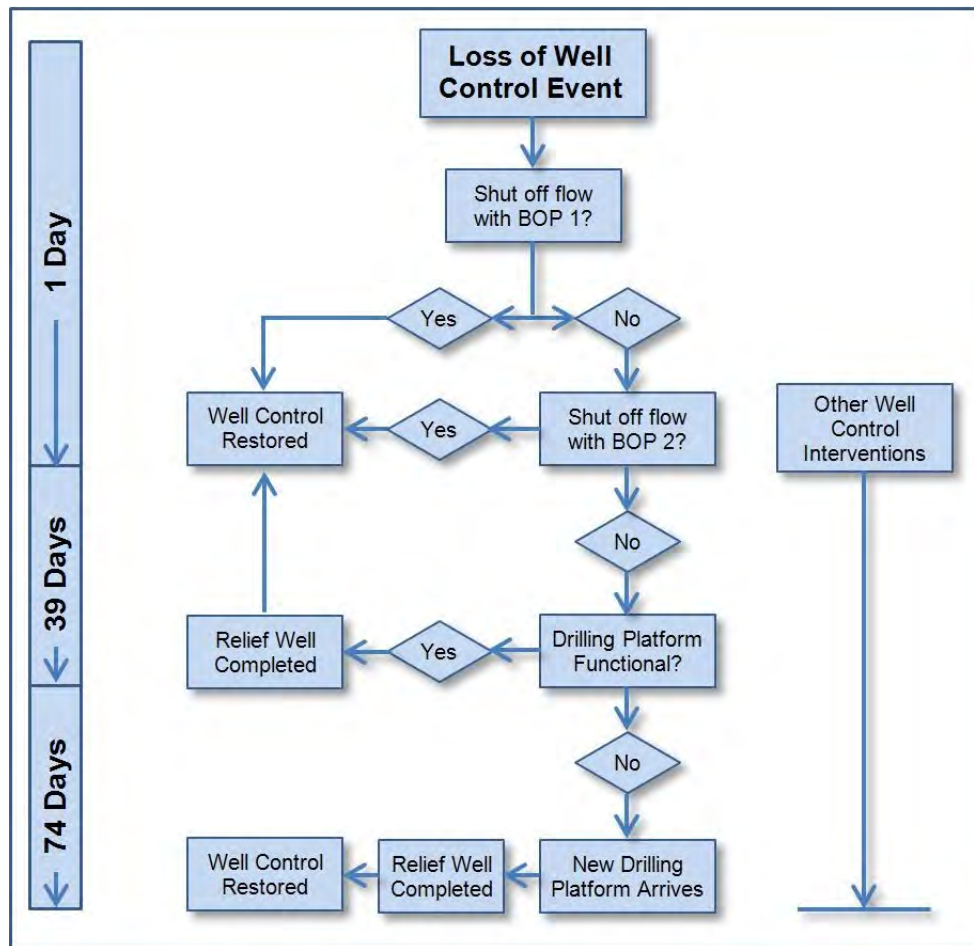


Figure 13 Timeline and sequence of response actions following a loss of well control event.

Effects of a VLOS on listed birds are discussed below for each of the five phases of the hypothetical scenario. The greatest potential for effects on listed birds occurs during Phase 2 (Offshore Oil). Onshore contact in Phase 3 would primarily affect nearshore habitats. In all cases, long-term recovery is likely, but most species would require unaffected/restored habitats for this to occur.

Phase 1 (Initial Event)

At Phase 1, the potential impact producing factors with relevance to listed birds could include an explosion and fire from a drilling structure. This phase does not include the release of oil (Phase 2). Few birds would be in the immediate vicinity of a drilling structure during an initial event; therefore, few adverse effects on listed birds are anticipated.

Phase 2 (Offshore Oil)

At Phase 2, direct exposure to oil and gas is the critical impact producing factor affecting listed birds. Oil in the Chukchi Sea would be a serious threat to certain birds because of its properties of forming a thin, liquid layer on the water surface. Bird deaths due to oil spills arise from exposure from wetting and loss of thermoregulatory ability, loss of buoyancy, or from matted plumage, inability to fly or forage, ingestion and inhalation of vapors. Some species of seabirds are vulnerable to oil spills because they spend the majority of their time on the sea surface and often aggregate in dense flocks.

Spectacled and Steller's Eiders. Spectacled and Steller's eiders must stage offshore in the spring if their breeding habitats are unavailable. Spring leads are open water areas used by spectacled and Steller's eiders during the spring (April – June). The eiders then move to the tundra to nest.

Most post-breeding spectacled and Steller's eiders move to the offshore. Some spectacled eiders stage offshore near Barrow in the Plover Islands. Steller's eiders make little use of this area because their

abundance is small and their distribution is limited. Spectacled and Steller's eiders migrate west to the Ledyard Bay Critical Habitat Unit (LBCHU). Critical habitat is a special designation under the Endangered Species Act that represents an area especially important to the persistence and recovery of a listed species. The LBCHU is especially important to spectacled eiders that molt there in dense flocks from July to November. Steller's eiders continue south and west of the LBCHU to different molting areas. Any oil entering the LBCHU has some potential to contact a dense flock of molting spectacled eiders, possibly including the late season aggregation of the North Slope's successful breeding females and their broods. This level of mortality likely could not be recovered, even if the eider populations otherwise remain stable.

Kittlitz's Murrelet. The Kittlitz's murrelet occurs in relatively limited numbers in the U.S. Chukchi Sea off the North Slope (Day et al., 2011). A large majority of Kittlitz's murrelets in the eastern Chukchi Sea could be killed if oil were to contact them in coastal areas. This species is widespread in low numbers throughout Alaska and birds offshore of the North Slope are at the outer range of the species distribution. Recovery would depend on dispersal from other areas, which could take several years.

Yellow-billed Loons. Loons using the Chukchi Sea typically migrate close to shore until they are south of Cape Lisburne, when they travel over pelagic waters on their migration to wintering areas. Loons using nearshore areas could be affected by oil contact in nearshore waters along the coast during the open water season. A hypothetical VLOS could affect nearshore areas used by nonbreeding loons or, later in the open-water season, loon broods. Depending on the spill timing, trajectory analysis, and locations of offshore loons, a large proportion of any sex-age class could experience extensive mortality. Yellow-billed loons in the Chukchi Sea are at particular risk due to their low numbers and low reproductive rate. Extensive mortality of certain sex-age classes could contribute to immediate or gradual population-level impacts, including the large-scale loss of the yellow-billed loons on the Arctic Slope.

Phase 3 (Onshore Contact)

Shorebird "hot-spots" are temporary concentration areas, most often associated with large river deltas in the Beaufort Sea. While there are no large river deltas along the Chukchi Sea, these same migrating shorebirds must use coastal areas of the Chukchi Sea as they migrate west to wintering areas out of the Arctic. Large numbers of shorebirds could come into contact with spilled oil along shoreline areas and could be affected during the post-breeding period through oil exposure and subsequent hypothermia if they encounter oil on shorelines. They could also be indirectly affected by eating contaminated prey or through mortality in their invertebrate food sources. Such mortality could have population-level effects, because large numbers of shorebirds could be affected.

Phase 4 (Spill Response and Cleanup)

Spill response activities could disturb and displace listed birds, which could have net beneficial effects by intentionally or unintentionally moving birds away from oiled areas. This displacement may move birds to unoiled areas, with negligible energetic costs, if these habitats were of similar quality. Listed birds could be harmed, however, if birds moved to inferior habitats where biological needs could not be met. Several species could be altered by cleanup efforts. While individual birds could physically relocate to other areas, those areas may be unsuitable and delay recovery.

Phase 5 (Long-term Recovery)

Long-term describes an impact producing factor that continues to produce effects in populations for more than 2 years. Many of the effects from direct contact of oil to most offshore and onshore areas have the potential to take several years to recover. As these were previously described under more direct effects for Phases 2 and 3, they are not repeated here.

Oil Spill Trajectory Analysis

The potential impacts to listed birds during each phase of the hypothetical scenario are addressed above. The estimated oil spill trajectories provided by the OSRA model are used to evaluate the likelihood of such impacts occurring.

This section describes the results estimated by the OSRA model of a hypothetical VLOS in the Chukchi Sea contacting specific Environmental Resource Areas (ERAs) that are important to listed birds. An ERA is a hypothetical polygon that represents a geographic area important to one or several bird species or species groups during a discrete amount of time. The ERA locations are incorporated by reference from LS 193 EIS (USDOI, MMS, 2007a). The ERAs important to marine and coastal birds are summarized in Appendix A, Table A.1-13 of the Sale 193 FEIS. The vulnerability of an ERA is based on the seasonal use patterns of birds using the area (Appendix A, Table A.1-12, USDOI, MMS 2007a).

The following paragraphs present the results (expressed as a percentage of trajectories contacting) estimated by the OSRA model of a hypothetical very large spill contacting habitats that are important to listed birds. It is possible that large aggregations of spectacled eiders could be contacted by a VLOS, depending on the location of the spill and location of the birds at the time of the spill.

Summer Spill

Under a hypothetical very large oil spill scenario for summer, the OSRA model estimates that $\geq 1\%$ of spill trajectories from any individual LA could contact ERAs important to birds within 60 days (Appendix B, Table B-2, USDOI, BOEMRE, 2011b).

Most post-breeding spectacled and Steller's eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Unit (LBCHU). The LBCHU (ERA 10) is especially important to spectacled eiders that molt there in dense flocks from July to November. Steller's eiders continue south and west of the LBCHU to different molting areas. The OSRA model estimates that 38% and 22% of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could contact spectacled eiders molting in the LBCHU (ERA 10) during the summer within the 60 and 360 day periods. The OSRA LA and the ERA are in close proximity to or overlap each other.

Many pre- and post-breeding waterfowl stage at Kasegaluk Lagoon, while other bird species breed or molt in or near the lagoon. The highest percentages of trajectories from a hypothetical VLOS that could contact Kasegaluk Lagoon (ERA 1) were 16% and 14% from LAs 11 and 10, respectively, within 60 and 360 days.

Waterfowl and other birds use Peard Bay, especially in the ice-free season, to breed, molt, and forage during migration. The highest percentage of trajectories from a hypothetical VLOS contacting Peard Bay (ERA 64) over a period of 60 days were 23% and 15% from LAs 13 and 12, respectively. The highest percentage of trajectories from a hypothetical very large spill contacting Peard Bay (ERA 64) during a 360 day period were 25% and 18% from LAs 13 and 12, respectively.

The OSRA model estimates that 9% and 8% of trajectories from LA8 or LA13, respectively, would contact spectacled eiders and other birds staging offshore Barrow in the Plover Islands (ERA 2) within 60 days during summer. Within 360 days the above values increase to 13% and 10%, respectively.

The Chukchi Sea spring lead system (ERAs 19-23) is used by listed birds as they move east to breeding areas or stage offshore if breeding habitats were unavailable. As the hypothetical VLOS would originate during the open water season (post-July 15), the spring lead system, by definition, would not exist or be available for contact within 60 days following a well control incident. The same situation exists for the Beaufort Sea spring lead system (ERAs 24-34). Within 360 days, however, $\leq 4\%$ of trajectories from a VLOS are estimated to contact the Chukchi Sea spring lead system and $\leq 6\%$ are estimated to contact the Beaufort Sea spring lead system.

Winter Spill

The OSRA model estimates that <16% of trajectories from a VLOS starting at LA1-LA13 could contact habitats (ERAs) that are important to listed birds (Appendix B, Table B-16, USDO, BOEMRE, 2011b). The OSRA model estimates that 16% and 10% of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could contact spectacled eiders molting in the LBCHU (ERA 10) during the winter within 360 days.

Many seaducks and other birds must stage offshore in the spring if their breeding habitats are unavailable. Environmental resource areas 19-23 make up the Chukchi Sea spring lead system (April-June) used by eiders and other birds during spring, and the highest percentages of trajectories from a hypothetical VLOS contacting these ERAs are 14% and 12% from LA12 and LA11, respectively during the winter 360 day assessment period. The percentage of trajectories estimated to contact these ERAs is highest because the launch areas and the ERAs are in close proximity to or overlap each other. A VLOS from the other LAs all are estimated to have percentages of trajectories <10% of contacting the spring lead systems of the Chukchi Sea (ERAs 19-23) and Beaufort Sea (ERAs 24-34).

The OSRA estimates ≤6% of trajectories from a hypothetical VLOS originating in any of the LAs could contact sea ducks staging offshore Barrow in the Plover Islands (ERA 2) for a winter 360 day analysis period. Steller's eiders make little use of ERA 2.

Kasegaluk Lagoon and Peard Bay are important areas for some sea ducks and other birds during open water in summer and fall, but if these sites were contacted by oil after November 1, the oil would likely over-winter and there would likely be effects on the habitat and the marine and coastal birds as they return in spring and begin to forage and breed in these areas. Up to 8% of trajectories from a hypothetical VLOS from any of the LAs could contact Peard Bay (ERA 64) or 11% for Kasegaluk Lagoon (ERA 1) within 360 days, during winter.

6.4. VLOS Conclusion

A VLOS has the greatest potential for affecting large numbers of listed birds in part due to its toxicity to individuals and their prey and the amount of time these birds spend on the surface of marine and coastal waters. Under a hypothetical VLOS scenario, listed birds in key areas or at key times could experience a variety of negative effects from petroleum exposure and habitat loss. Key areas evaluated included:

- 1) Ledyard Bay
- 2) Kasegaluk Lagoon
- 3) Peard Bay
- 4) the spring open-water lead systems

The Ledyard Bay Critical Habitat Unit is especially important to spectacled eiders that molt there in dense flocks from July to November. A VLOS during periods of peak use could affect large numbers of listed eiders in the LBCHU, and smaller numbers of loons and murrelets.

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8.0 APPENDIX A SUPPORTING INFORMATION

Table A.1- 1 Large and Small Spill Sizes, Source of Spill, Type of Oil, Number and Size of Spill and Receiving Environment BOEMRE Assumes for Analysis in the Beaufort Sea.

BE Section	Source of Spill	Type of Oil	Number and Size of Spill(s) (Barrels)	Receiving Environment
Large Spills ($\geq 1,000$ barrels)				
	Offshore Pipeline Platform/Storage Tank	Crude Condensate Or Diesel	1 spill 4,600 Or 1,500 barrels	Containment Open Water Under Ice On Top of Sea Ice Broken Ice Coastal Shoreline
Small Spills¹ (< 1,000 barrels)				
	Offshore and/or Onshore Operational Spills from All Sources	Diesel or Crude	67 spills <1 barrel 21 spills ≥ 1 barrel but <25 barrels 1 spills ≥ 25 and <500 barrels 0 spills ≥ 500 and <1,000 barrels	Containment Open Water On Top of Sea Ice Broken Sea Ice Snow/Ice Tundra Coastal Shoreline
	Onshore and/or Offshore Operational Spills from All Sources	Refined	220 spills of 0.7 barrels each	

Note: ¹Tables A.1-29 through A.1-36 in Appendix A.1 show the distribution of small crude and refined spills.
Source: USDO, MMS, Alaska OCS Region (2008).

Table A.1- 2 Large and Small Spill Sizes, Source of Spill, Type of Oil, Number and Size of Spill and Receiving Environment BOEMRE Assumes for Analysis in the Chukchi Sea.

BE Section	Source of Spill	Type of Oil	Number and Size of Spill(s) (Barrels)	Receiving Environment
Large Spills ($\geq 1,000$ barrels)				
	Offshore Pipeline Platform/Storage Tank	Crude Condensate Or Diesel	1 spill 4,600 Or 1,500 barrels	Containment Open Water Under Ice On Top of Sea Ice Broken Ice Coastal Shoreline
Small Spills¹ (< 1,000 barrels)				
	Offshore and/or Onshore Operational Spills from All Sources	Diesel or Crude	133 spills <1 barrel 43 spills ≥ 1 barrel but <25 barrels 2 spills ≥ 25 and <500 barrels 1 spill ≥ 500 and <1,000 barrels	Containment Open Water On Top of Sea Ice Broken Sea Ice Snow/Ice Tundra Coastal Shoreline
	Onshore and/or Offshore Operational Spills from All Sources	Refined	440 spills of 0.7 barrels each	

Note: ¹Tables A.1-29 through A.1-36 in Appendix A.1 show the distribution of small crude the refined spills.
Source: USDO, MMS, Alaska OCS Region (2008).

Table A.1- 3 Number of Well-Control Incidents with Pollution per Year in the Gulf of Mexico and Pacific OCS Regions.

Year	Total Number of Incidents	Incidents with Condensate/ Crude Oil	Condensate/Crude Oil Spilled (Barrels)			Production	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
			Production, Workover, Completion, P&A	Drilling	Total Exploration and Development		Total	Exploration	Development	Unknown				
1956	1	0	—	—	0	—	1	—	1	0	—	204	46	258
1957	1	0	—	—	0	—	1	—	1	0	—	333	58	391
1958	2	1	0.9	—	0.9	—	1	1	—	0	1	210	65	275
1959	1	0	—	—	0	—	1	—	1	0	—	229	96	325
1960	2	0	—	—	0	1	1	1	—	0	—	290	138	428
1961	0	0	—	—	0	—	—	—	—	0	—	351	133	484
1962	1	0	—	—	0	—	1	—	1	0	—	385	159	544

Year	Total Number of Incidents	Incidents with Condensate/ Crude Oil	Condensate/Crude Oil Spilled (Barrels)			Production	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
			Production, Workover, Completion, P&A	Drilling	Total Exploration and Development		Total	Exploration	Development	Unknown				
1963	1	0	—	—	0	—	1	1	—	0	—	400	209	609
1964	7	3	10,280	100	10,380	4	3	2	1	0	—	507	234	742
1965	5	2	0.9	1688	1,688.9	1	4	1	3	0	—	648	194	842
1966	2	2	0.9	0.9	1.8	—	1	—	1	0	1	628	299	973
1967	2	1	0.9	—	0.9	0	—	—	—	—	2	638	321	988
1968	8	0	—	—	0	1	6	2	4	—	1	735	358	1094
1969	3	3	—	82,500.9	82,500.9	0	3	1	2	0	—	731	254	993
1970	3	2	118,000.0	—	118,000.0	1	1	—	1	0	1	756	248	1006
1956-1970	39	14	128,283.60	84,289.80	212,573.40	8	25	9	16	0	6	7,045	2,812	9,952
Major Regulatory Changes to Outer Continental Shelf Lands Act														
1971	6	2	460	—	460	2	2	1	1	0	2	620	285	909
1972	6	2	2	0.9	2.9	1	4	2	2	—	1	608	309	917
1973	3	1	—	0.9	0.9	0	3	2	1	—	—	569	321	890
1974	6	2	275	—	275	2	2	1	1	—	2	512	355	869
1975	7	1	0.9	—	0.9	—	5	4	1	—	2	569	334	904
1976	6	0	—	—	0	1	5	1	4	—	—	851	317	1169
1977	10	1	2	—	2	1	4	3	1	—	5	975	398	1373
1978	12	1	0.9	—	0.9	—	8	4	4	—	4	935	361	1298
1979	5	2	—	1.8	1.8	—	5	4	1	—	—	895	420	1316
1980	8	1	1	—	1	2	4	3	1	—	2	943	412	1356
1981	10	5	66.7	0.9	67.6	1	3	1	2	—	6	1012	400	1412
1982	9	2	1.8	—	1.8	—	5	1	4	—	4	970	457	1427
1983	12	1	—	2	2	—	10	5	5	—	2	872	458	1330
1984	5	0	—	—	0	—	4	3	1	—	1	862	663	1525
1985	6	1	50	—	50	0	4	3	1	—	2	783	574	1361
1986	2	0	—	—	0	—	1	—	1	—	1	517	296	813
1987	8	2	61	—	61	3	2	2	—	—	3	534	439	973
1988	4	1	4.5	—	4.5	1	2	1	1	—	1	510	584	1094
1989	12	0	—	—	0	3	7	4	3	0	2	572	489	1061
1990	7	3	17.5	—	17.5	0	3	1	1	1	4	638	521	1159
1991	8	1	—	0.8	0.8	—	6	3	3	0	2	483	350	833
1992	3	1	—	100	100	—	3	3	—	—	—	376	229	605
1993	4	0	—	—	0	—	4	1	3	—	—	645	365	1010
1994	1	0	—	—	0	—	—	—	—	—	1	686	438	1124
1995	1	0	—	—	0	—	1	0	1	—	—	784	395	1179
1996	4	0	—	—	0	—	2	1	1	—	2	805	462	1267
1997	5	0	—	—	0	—	4	1	3	—	1	932	549	1481
1998	9	3	2.6	1.62	4.22	3	3	2	1	—	3	665	495	1161
1999	5	1	125	—	125	—	3	1	2	—	2	676	371	1048
2000	9	3	0.02	200.5	200.52	—	8	6	2	—	1	950	443	1396
2001	10	1	1	—	1	2	5	2	3	—	3	867	411	1278
2002	6	3	350.505	—	350.505	2	3	1	2	—	1	654	310	964
2003	5	1	10	—	10	2	2	0	1	1	1	557	354	911
2004	6	4	2.5	22.06	24.56	1	3	3	—	—	2	569	363	932
2005	4	0	—	—	0	—	4	1	3	—	—	482	355	841
2006	2	2	10	24.5	34.5	—	1	1	—	—	1	375	414	789
2007	8	—	—	—	—	2	2	2	—	—	4	328	300	630
2008	9	0	—	—	0	3	4	1	3	—	2	304	267	571
2009	6	2	27.94	—	27.94	1	1	1	—	—	4	179	147	338
2010	4	1	—	TBD	TBD	3	1	1	—	—	0	181	80	267
71-10*	253	51	1,472.87	355.98	1,828.85	36	143	77	64	2	74	26,245	15,491	41,781

Notes: Wells drilled columns include hydrocarbon, sulfur and salt wells. The total column includes core tests and relief wells in addition to exploration and development wells; therefore the total column may be slightly higher than the sum of the development and exploration wells columns for some years.

TBD - the final volume for the Deepwater Horizon that occurred on 4/20/2010 has not been determined by BOEMRE.

The 1971-2010 spill volume totals for the columns showing Drilling and Total Exploration and Development do not include the volume for the Deepwater Horizon incident that occurred on 4/20/2010.

Source: USDO, BOEMRE, Accident Investigation Board, 2011

Table A.1- 4 Exploration Spills on the Arctic OCS.

Lease No.	Sale Area	Operator	Date	Time 24 Hr	Facility	Substance	Amt. (Gal)	Cause of Spill	Response Action	Amount Recovered
0344	71	Sohio	7/22/1981	11:00	Mukluk Island	Diesel	0.50	Leaking line on portable fuel trailer	Sorbents used to remove spill. Contaminated gravel removed.	0.05
0344	71	Sohio	7/22/1981	14:00	Mukluk Island	Diesel	1.00	Overfilled fuel tank on equipment	Sorbents used to remove spill. Contaminated gravel removed.	1.00
0280	71	Exxon	8/7/1981		Beaufort Sea I	Hydraulic Fluid	1.00	Broken hydraulic line on ditch witch.	Fluid picked up with shovels.	1.00
0280	71	Exxon	8/8/1981		Beaufort Sea I	Trans. Fluid	0.25	Overfilling of transmission fluid.	Fluid picked up and placed in plastic bags.	0.25
0280	71	Exxon	1/11/1982		Beaufort Sea I	Hydraulic Fluid	0.50	Broken hydraulic line.	Fluid picked up and stored in plastic bags.	0.50
0280	71	Exxon	1/11/1982		Alaska Beaufort Sea I	Diesel	3.00	Overfilled catco 90-3 tank.	Fluid picked up.	3.00
0280	71	Exxon	1/17/1982		Beaufort Sea I	Diesel	1.00	Tank on catco 90-14 overfilled.	Fluid picked up and stored in plastic bags.	1.00
0280	71	Exxon	1/21/1982		Beaufort Sea I	Hydraulic Fluid	0.25	Broken hydraulic line on ditch witch.	Fluid picked up.	0.25
0371	71	Amoco	3/16/1982	N/A	Sandpiper Gravel Island	Unknown	1.00	Seeping from Gravel Island.	Sorbent pads.	Unknown
0849	87	Union Oil	9/4/1982	14:00	Canmar Explorer II	Unknown	1.00	Transfer of test tank from drillship to barge.	None	None
0871	87	Shell Western	9/5/1982	18:55	Canmar Explorer II	Light Oil	0.50	Washing down cement unit, drains not plumbed to oil/water separator.	None	None
N/A	87	Shell	9/14/1982	19:00	Canmar II Drillship	Diesel	30.00	Tank vent overflowed during fuel transfer.	Deployed sorbent pads and pump.	30.00
0191	BF	Exxon	11/11/1982	10:00	Beechey Pt. Gravel Is.	Lube Oil	1.00	Loader tipped over lube oil drum	Oil cleaned up with sorbents. Contaminated gravel removed	1.00
0191	BF	Exxon	1/15/1983	10:00	Beechey Pt. Gravel Is.	Diesel	0.12	Fuel truck spilled diesel as it climbed a 40 degree ramp to island	Sorbents used and contaminated gravel removed	0.12
0191	BF	Exxon	1/23/1983	9:00	Beechey Pt. Gravel Is.	Hydraulic Fluid	2.50	Hydraulic line on backhoe broke	1 gallon in water. Boom deployed with sorbents, Contaminated gravel removed	2.50
0191	BF	Exxon	8/29/1983	6:30	Beechey Pt. Gravel Is.	Hydraulic Fluid	0.20	Hydraulic line on backhoe broke	Spill contained on island surface. Sorbents used and contaminated gravel removed.	0.25
0196	BF	Shell	8/30/1983		Ice Road to Tern Island	Hydraulic Fluid	10.0	Broken hydraulic line on rollogon	Unknown	Unknown
0191	BF	Exxon	2/26/1985	17:30	Beechey Pt. Gravel Is.	Hydraulic Fluid	0.37	Hydraulic line broke	Contaminated Snow Removed	0.37
0196	BF	Shell	3/1/1985	1:30	Ice Road to Tern Island	Hydraulic Fluid	3.00	Hydraulic line broke	Unknown	3.00
0191	BF	Exxon	3/2/1985		Beechey Pt. Gravel Is.	Gasoline	0.01	Operational Spill	Snow shoved into plastic bag.	0.01
0191	BF	Exxon	3/4/1985		Beechey Pt. Gravel Is.	Waste Oil	2.00	Drum of waste oil punctured	Snow recovered	2.00
0196	BF	Shell	3/4/1985	15:30	Tern Gravel Island	Crude Oil	1.00	Well Separator overflowed, crude oil escaped	Line boom deployed	Unknown
0196	BF	Shell	3/6/1985	16:30	Tern Gravel Island	Crude Oil	15.00	Test burner was operating poorly	Containment Boom deployed	Unknown
0196	BF	Shell	9/24/1985	16:00	Tern Gravel Island	Crude Oil	2.00	Oil released from steam heat coil when Halliburton tank moved	Sorbents and hand shovel used	2.00
0191	BF	Shell	10/4/1985	8:45	Enroute to Tern Gravel Island	Jet fuel B	800.00	Wire sling broke during helicopter transport of fuel blivits	Contaminated Snow Removed. Test holes drilled with no fuel below snow.	Unknown
0196	BF	Shell	10/29/1985	14:00	Tern Gravel Island	Crude Oil	2.00	Test oil burner malfunction	Contaminated snow removed	2.00

Lease No.	Sale Area	Operator	Date	Time 24 Hr	Facility	Substance	Amt. (Gal)	Cause of Spill	Response Action	Amount Recovered
0196	BF	Shell	6/27/1986	13:30	Tern Gravel Island	Crude Oil	3.00	Test oil burner malfunction	Spray picked up with sorbents. Bladed up dirty snow.	2.00
0943	87	Tenneco	1/24/1988	13:00	SSDC/MAT	Gear oil	220.0	Helicopter sling failure during transfer of drums to SSDC	Scooped up contaminated snow and ice	220.0
1482	109	SWEPI	7/7/1989	3:00	Explorer III Drillship	Hydraulic fluid	10.0	Hydraulic line connector	Sorbent pads	0.84
1092	97	AMOCO	10/1/1991	2:00	CANMAR Explorer	Hydraulic fluid	2.00	Hydraulic line rupture	None	None
0865	87	ARCO	7/24/1993		Beaudril Kulluk	Diesel	0.06	Residual fuel in bilge water	None	None
0866	87	ARCO	9/8/1993	18:30	CANMAR Kulluk	Hydraulic fluid	1.26	Seal on shale shaker failed	None	None
0866	87	ARCO	9/24/1993		CANMAR Kulluk	Fuel	4.00	Fuel transfer in rough weather	3 gallons on deck of barge recovered, none in sea	3.00
1597	124	ARCO	10/31/1993		CANMAR Kulluk	Fuel	0.50	Released during emptying of disposal caisson	None	None
1585	124	BP Alaska	1/20/1997		Ice Road to Tern Island	Diesel, Hydraulic Fluid	10.5	Truck went through ice; fuel line ruptured	Scooped up contaminated snow and ice. Some product entered water	Unknown

Source: USDO, MMS, Alaska OCS Region (2008).

Table A.1- 5 Land Segment ID and the Percent Type of Environmental Sensitivity Index Shoreline Closest to the Ocean for United States, Alaska Shoreline.

ID	Geographic Place Names	1A	1B	2A	3A	3C	4	5	6A	6B	7	8A	8B	8E	9A	9B	10A	10E	U
40	Ah-Gude-Le-Rock, Dry Creek, Lopp Lagoon, Mint River	—	—	1	16	0	—	29	0	—	19	6	—	—	8	—	15	1	—
41	Ikpek, Ikpek Lagoon, Pinguk River, Yankee River	—	—	4	30	2	—	0	—	—	22	5	—	—	9	—	14	2	—
42	Arctic Lagoon, Kugrupaga Inlet, Nuluk River	—	—	3	10	2	—	7	0	—	9	17	—	—	17	—	31	2	—
43	Sarichef Island, Shishmaref Airport	—	—	1	24	3	1	3	—	—	9	13	—	—	31	0	9	2	—
44	Cape Lowenstern, Egg Island, Shishmaref, Shishmaref Inlet	—	—	10	9	3	0	1	—	—	10	2	—	—	22	—	26	—	—
45		—	—	1	5	5	—	—	—	—	5	18	—	—	15	—	51	—	—
46	Cowpack Inlet and River, Kalik River, Kivido, Singeak, Singeakpuk River	—	—	4	17	2	—	—	—	—	26	2	—	—	12	1	28	—	—
47	Kitluk River, Northwest Corner Light, West Fork Espenberg River	—	—	—	24	12	—	—	—	—	16	14	—	—	4	—	18	3	—
48	Cape Espenberg, Espenberg, Espenberg River	0	—	7	13	5	—	6	9	—	12	12	—	—	12	—	20	1	—
49	Kungealoruk Creek, Kougachuk Creek, Pish River	—	—	0	5	7	—	20	—	—	3	4	—	—	16	—	33	—	—
50	Clifford Point, Cripple River, Goodhope River, Rex Point, Sullivan Bluffs	—	—	—	—	—	—	24	18	—	0	22	—	—	1	—	14	—	—
51	Cape Deceit, Deering, Kugruk Lagoon and River, Sullivan Lake, Toawlevic Point	1	—	—	—	1	1	23	6	—	9	8	1	—	2	—	41	6	—
52	Motherwood Point, Ninemile Point, Willow Bay	17	—	—	—	3	—	12	32	—	2	—	—	—	5	—	17	12	—

ID	Geographic Place Names	1A	1B	2A	3A	3C	4	5	6A	6B	7	8A	8B	8E	9A	9B	10A	10E	U
53	Kiwalik, Kiwalik Lagoon, Middle Channel Kiwalk River, Minnehaha Creek, Mud Channel Creek, Mud Creek	4	—	—	1	1	—	13	10	—	11	10	—	—	26	—	22	2	—
54	Baldwin Peninsula, Lewis Rich Channel	2	—	—	—	2	—	43	3	—	3	6	—	—	0	—	35	3	—
55	Cape Blossom, Pipe Spit	—	—	—	—	10	—	35	10	—	—	2	—	—	6	—	9	20	—
56	Kinuk Island, Kotzebue, Noatak River	—	—	—	—	3	—	2	8	—	4	5	0	—	29	—	47	—	—
57	Aukulak Lagoon, Igisukruk Mountain, Noak, Mount, Sheshalik, Sheshalik Spit	—	—	1	—	—	—	37	—	—	—	1	—	—	22	—	36	—	—
58	Cape Krusenstern, Eigaloruk, Evelukpalik River, Kasik Lagoon, Krusenstern Lagoon,	—	—	—	—	8	0	30	7	—	4	3	—	—	2	—	30	16	—
59	Imik Lagoon, Ipiavik Lagoon, Kotlik Lagoon, Omikviorok River	0	0	—	—	1	—	62	6	—	3	6	—	—	2	—	6	14	—
60	Imikruk Lagoon, Imnakuk Bluff, Kivalina, Kivalina Lagoon, Singigrak Spit, Kivalina River, Wulik River	—	—	—	—	0	2	23	2	—	1	5	—	—	8	—	35	22	—
61	Asikpak Lagoon, Cape Seppings, Kavrarak Lagoon, Pusaluk Lagoon, Seppings Lagoon	—	—	—	—	—	3	32	13	—	—	2	—	—	—	—	—	49	—
62	Atosik Lagoon, Chariot, Ikaknak Pond, Kisimilok Mountain, Kuropak Creek, Mad Hill	—	—	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—
63	Akoviknak Lagoon, Cape Thompson, Crowbill Point, Igilerak Hill, Kemegrak Lagoon	7	—	—	—	—	—	93	—	—	—	—	—	—	—	—	—	—	—
64	Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Kukpuk River, Pingu Bluff, Point Hope, Sinigrok Point,	16	—	—	—	—	—	82	3	—	—	—	—	—	—	—	—	—	—
65	Buckland, Cape Dyer, Cape Lewis, Cape Lisburne	29	—	—	—	—	—	60	5	—	—	—	—	—	—	—	—	—	—
66	Ayugatak Lagoon	51	—	—	—	—	—	46	—	—	—	—	—	—	—	—	—	—	—
67	Cape Sabine, Pitmegea River	51	—	—	—	9	—	40	—	—	—	—	—	—	—	—	—	—	—
68	Agiak Lagoon, Punuk Lagoon	—	—	—	—	10	—	86	—	—	—	—	—	—	—	—	—	—	—
69	Cape Beaufort, Omalik Lagoon	—	—	—	—	45	—	50	—	—	—	—	—	—	—	—	—	—	—
70	Kuchaurak Creek, Kuchiak Creek	—	—	—	20	3	—	34	—	—	—	—	—	1	12	9	10	10	—
71	Kukpowruk River, Naokok, Sitkok Point	—	—	—	34	7	—	21	—	—	—	—	—	—	25	7	2	2	3
72	Kokolik River, Point Lay, Siksrupak Point	—	—	—	30	3	—	7	—	—	—	—	—	3	19	19	—	5	14
73	Akunik Pass, Tungaich Point, Tungak Creek	—	—	—	27	14	—	7	—	—	—	—	—	—	19	8	—	3	22
74	Kasegaluk Lagoon, Solivik Island, Utukok River	—	—	—	21	8	—	1	—	—	—	—	—	—	19	9	—	—	43
75	Akeonik, Icy Cape, Icy Cape Pass	—	—	—	25	12	—	14	—	—	—	—	—	3	16	18	—	2	10
76	Akoliakatat Pass, Avak Inlet, Tunalik River	—	—	—	21	21	—	7	—	—	—	—	—	4	10	7	—	10	20
77	Nivat Point, Nokotlek Point, Ongoravik River	—	—	—	47	10	—	30	—	—	—	—	—	—	2	9	1	1	1
78	Kuk River, Point Collie, Sigekruk Point,	—	—	—	46	13	—	23	—	—	—	—	—	1	3	2	—	9	3

ID	Geographic Place Names	1A	1B	2A	3A	3C	4	5	6A	6B	7	8A	8B	8E	9A	9B	10A	10E	U
79	Point Belcher, Wainwright, Wainwright Inlet	—	—	—	26	26	—	37	—	—	—	—	—	—	—	11	—	—	—
80	Eluksingiak Point, Igklo River, Kugrua Bay	—	—	—	23	42	—	16	—	—	—	—	—	9	4	2	—	5	—
81	Peard Bay, Point Franklin, Seahorse Islands, Tachinisok Inlet	—	—	—	60	26	—	7	—	—	—	—	—	5	—	2	—	—	—
82	Skull Cliff	5	—	—	—	78	—	17	—	—	—	—	—	—	—	—	—	—	—
83	Nulavik, Loran Radio Station	1	—	—	—	91	—	8	—	—	—	—	—	—	—	—	—	—	—
84	Walakpa River, Will Rogers and Wiley Post Memorial	—	—	—	—	4	—	96	—	—	—	—	—	—	—	—	—	—	—
85	Barrow, Browerville, Elson Lagoon	—	—	—	—	—	20	38	—	—	2	—	—	28	—	—	—	10	1
86	Dease Inlet, Plover Islands, Sanigaruk Island	—	—	—	11	—	15	23	—	—	13	—	—	35	—	—	—	3	—
87	Igalik Island, Kulgurak Island, Kurgorak Bay, Tangent Point	—	—	—	7	—	4	5	—	—	7	—	—	34	27	3	—	13	—
88	Cape Simpson, Piasuk River, Sinclair River, Tulimanik Island	—	—	—	—	—	4	5	—	—	3	—	—	19	48	2	—	4	15
89	Ikpikpuk River, Point Poleakoon, Smith Bay	—	—	—	—	—	—	—	—	—	-	—	—	8	73	—	—	—	19
90	Drew Point, Kolovik, McLeod Point,	—	—	—	—	—	25	—	—	—	15	—	—	60	—	—	—	—	—
91	Lonely, Pitt Point, Pogik Bay, Smith River	—	—	—	—	—	9	8	—	—	4	—	—	27	30	—	—	—	22
92	Cape Halkett, Esook Trading Post, Garry Creek	—	—	—	0	3	16	—	—	—	5	—	—	72	—	—	—	4	—
93	Atigaru Point, Eskimo Islands, Harrison Bay,	—	—	—	15	27	8	2	—	—	2	—	—	16	—	—	1	22	7
94	Fish Creek, Tingmeachsiovik River	—	—	—	11	4	—	—	—	—	12	—	—	3	32	—	—	38	—
95	Anachlik Island, Colville River, Colville River Delta	—	—	—	7	2	—	—	—	—	42	—	—	2	36	—	1	8	—
96	Kalubik Creek, Oliktok Point, Thetis Mound,	—	—	—	19	0	—	12	1	—	8	—	—	9	1	—	—	25	25
97	Beechey Point, Bertoncini Island, Bodfish Island, Cottle Island, Jones Islands, Milne Point, Simpson Lagoon	—	—	—	41	5	—	18	—	—	7	—	—	8	0	—	—	10	11
98	Gwydyr Bay, Kuparuk River, Long Island	—	—	—	10	1	—	23	—	—	6	—	—	3	23	—	—	26	7
99	Duck Island, Foggy Island, Gull Island, Heald Point, Howe Island, Niakuk Islands, Point Brower	—	—	—	—	4	—	14	1	—	9	—	1	2	51	—	—	10	4
100	Foggy Island Bay, Kadleroshilik River, Lion Point, Shaviovik River, Tigvariak Island	—	—	—	10	1	—	8	—	—	27	—	—	4	5	—	—	39	5
101	Bullen Point, Point Gordon, Reliance Point	—	—	—	10	3	—	39	—	—	5	—	—	3	—	—	—	25	15
102	Flaxman, Maguire, and North Star Islands, Point Hopson, Point Sweeney, Point Thomson, Staines River	—	—	—	11	3	—	37	2	—	8	—	—	7	—	—	—	14	18
103	Brownlow Point, Canning River, Tamayariak River	—	—	—	—	2	18	6	—	—	12	—	—	7	35	—	—	1	19
104	Camden Bay, Collinson Point, Katakturuk River, Konganevik Point, Simpson Cove	—	—	—	—	—	8	30	—	—	9	—	—	14	2	2	—	10	26

ID	Geographic Place Names	1A	1B	2A	3A	3C	4	5	6A	6B	7	8A	8B	8E	9A	9B	10A	10E	U
105	Anderson Point, Carter Creek, Itkilyariak Creek, Kajutakrok Creek, Marsh Creek, Sadlerochit River	—	—	—	—	—	14	30	—	—	21	—	—	6	5	—	2	—	23
106	Arey Island, Arey Lagoon, Barter Island, Hulahula River, Okpilak River	—	—	—	—	—	2	7	—	—	23	—	—	14	10	—	—	—	43
107	Bernard Harbor, Jago Lagoon, Kaktovik, Kaktovik Lagoon	—	—	—	—	—	4	23	—	—	19	—	—	6	15	—	—	—	34
108	Griffin Point, Oruktalik Lagoon, Pokok Lagoon	—	—	—	—	—	13	24	—	—	20	—	—	15	12	—	1	—	15
109	Angun Lagoon, Beaufort Lagoon, Nuvagapak Lagoon,	—	—	—	—	—	28	11	—	—	32	—	—	15	0	—	—	1	13
110	Aichilik River, Egaksrak Lagoon, Egaksrak River, Icy Reef, Kongakut River, Siku Lagoon	—	—	—	—	—	3	12	—	—	7	—	—	3	39	—	—	3	34
111	Demarcation Bay, Demarcation Point, Gordon, Pingokraluk Lagoon	—	—	—	—	—	9	51	—	—	14	—	—	8	1	—	—	—	17

Key:

ID Description

1A Exposed Rocky Shore
 1B Exposed Solid Man Made Structure
 2A Exposed Wave-cut Platforms in Bedrock, Mud or Clay
 3A Fine- to Medium-grained Sand Beaches.
 3C Tundra Cliffs.
 4 Coarse Grained Sand Beaches
 5 Mixed Sand and Gravel Beaches.
 6A Gravel Beaches.
 7 Exposed Tidal Flats.

ID Description

8A Sheltered Rocky Shores and Sheltered Scarps in Bedrock, Mud or Clay
 8B Sheltered, Solid Man-made Structures.
 8E Peat Shorelines.
 9A Sheltered Tidal Flats
 9B Sheltered Vegetated Low Banks
 10A Salt- and Brackish- water Marshes.
 10E Inundated Low-lying Tundra.
 U Unranked

Source: USDOC, NOAA, (2002), Research Planning, Inc (2002).

Table A.1- 6 Fate and Behavior of a Hypothetical 1,500-Barrel Oil Spill from a Platform in the Beaufort Sea.

	Summer Spill ¹				Meltout Spill ²			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	81	73	58	28	84	78	73	65
Oil Dispersed (%)	2	5	16	43	0.2	0.6	2	6
Oil Evaporated (%)	17	22	26	29	16	21	25	29
Thickness (mm)	3.5	2.1	1.2	1	7.6	2.8	1.7	1
Discontinuous Area (km ²) ^{3,4}	2	9	44	181	2	7	18	143
Estimated Coastline Oiled (km) ⁵	29				32			

Note: For the Proposed Action, the median platform spill is assumed to be 1,500 barrels.

Table A.1- 7 Fate and Behavior of a Hypothetical 4,600-Barrel Oil Spill from a Pipeline in the Beaufort Sea.

	Summer Spill ¹				Meltout Spill ²			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	83	77	65	40	85	81	71	69
Oil Dispersed (%)	1	3	10	32	0.1	0.4	3	4
Oil Evaporated (%)	16	20	25	28	15	19	26	27
Thickness (mm)	3.5	2.1	1.2	1	7.7	4.9	2.9	1.7
Discontinuous Area (km ²) ^{3,4}	4	16	77	320	3	13	61	252
Estimated Coastline Oiled (km) ⁵	49				54			

Notes: Calculated with the SINTEF oil-weathering model Version 3.0 of Reed et al. (2005a) and assuming an Alaska North Slope crude type. For the Proposed Action, the median pipeline spill is assumed to be 4,600 barrels.

¹ Summer (July through September), 12-knot wind speed, 2 degrees Celsius, 0.4-meter wave height.

² Meltout Spill. Spill is assumed to occur in May into first-year pack ice, pools 2-centimeter thick on ice surface for 2 days at 0 degrees Celsius prior to meltout into 50% ice cover, 11-knot wind speed, and 0.1 meter wave heights.

³ This is the area of oiled surface.

⁴ Calculated from Equation 6 of Table 2 in Ford (1985) and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume. Note that ice dispersion occurs for about 30 days before meltout.

⁵ Calculated from Equation 17 of Table 4 in Ford (1985) and is the results of stepwise multiple regression for length of historical coastline affected.

Source: USDOI, MMS, Alaska OCS Region (2003).

Table A.1- 8 Fate and Behavior of a Hypothetical 1,500-Barrel Diesel Oil Spill from a Platform in the Beaufort or Chukchi Sea.

	Summer Spill ¹				Meltout Spill ²			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	80	47	0	-	88	65	20	0
Oil Dispersed (%)	11	40	69	-	3	11	40	53
Oil Evaporated (%)	9	33	31	-	9	24	40	47
Thickness (mm)	0.6	0.3	0.1	-	0.7	0.4	0.2	0.1

Table A.1- 9 Fate and Behavior of a Hypothetical 1,500-Barrel Condensate Oil Spill from a Platform in the Beaufort or Chukchi Sea.

	Summer Spill ¹				Meltout Spill ²			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	0	-	-	-	13	6	0	-
Oil Dispersed (%)	21	-	-	-	5	10	15	-
Oil Evaporated (%)	79	-	-	-	82	84	85	-
Thickness (mm)	0.3	-	-	-	0.3	0.2	0.1	-

Table A.1- 10 Fate and Behavior of a Hypothetical 4,600-Barrel Condensate Oil Spill from a Pipeline in the Beaufort and Chukchi Sea.

	Summer Spill ¹				Meltout Spill ²			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	2	0	-	-	17	5	0	-
Oil Dispersed (%)	19	21	-	-	3	11	15	-
Oil Evaporated (%)	79	79	-	-	80	84	85	-
Thickness (mm)	0.4	0.2	-	-	0.4	0.2	0.15	-

Notes: Calculated with the SINTEF oil-weathering model Version 3.0 of Reed et al. (2005a) and assuming a diesel oil and a Slepner condensate. For the Proposed Actions, the median platform spill is assumed to be 1,500 barrels and the median pipeline spill is assumed to be 4,600 barrels.

¹ Summer Spill, 10-knot wind speed, 3 degrees Celsius, 0.4-meter wave height.

² Meltout Spill. Meltout into 50% ice cover, 10-knot wind speed, and 0 degrees Celsius.

Source: USDO, MMS, Alaska OCS Region (2008).

Table A.1- 11 Fate and Behavior of a Hypothetical 1,500-Barrel Crude Oil Spill from a Platform in the Chukchi Sea.

	Summer Spill ¹				Meltout Spill ²			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	71	67	62	41	71	66	61	55
Oil Dispersed (%)	0	0	1	2	0	1	2	5
Oil Evaporated (%)	29	33	37	57	29	33	37	40
Thickness (mm)	1	1	1	1	1.3	1	1	1
Discontinuous Area (km ²) ^{3,4}	7	29	139	577	2	10	23	188
Estimated Coastline Oiled (km) ⁵	25				30			

Table A.1- 12 Fate and Behavior of a Hypothetical 4,600-Barrel Crude Oil Spill from a Pipeline in the Chukchi Sea.

	Summer Spill ¹				Meltout Spill ²			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	70	64	56	44	71	66	61	55
Oil Dispersed (%)	1	3	7	16	0	1	2	5
Oil Evaporated (%)	29	33	37	40	29	33	37	40
Thickness (mm)	1.01	1	1	1	1.3	1	1	1
Discontinuous Area (km ²) ^{3,4}	12	51	243	1008	4	16	80	332
Estimated Coastline Oiled (km) ⁵	42				51			

Notes: Calculated with the SINTEF oil-weathering model Version 3.0 of Reed et al. (2005a) and assuming an Alpine Composite crude type or Diesel oil. For the Proposed Action, the median pipeline spill is assumed to be 4,600 barrels. For Proposed Action, the median platform spill is assumed to be 1,500 barrels.

¹ Summer (June 1-October 31), 8-knot wind speed, 2.7 degrees Celsius, 0.4-meter wave height.

² Meltout Spill (November 1-May 31). Spill is assumed to occur into first-year pack ice, pools 2-centimeter thick on ice surface for 2 days at -1 degrees Celsius prior to meltout into 50% ice cover, 10-knot wind speed, and 0.1 meter wave heights.

³ This is the area of oiled surface.

⁴ Calculated from Equation 6 of Table 2 in Ford (1985) and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume. Note that ice dispersion occurs for about 30 days before meltout.

⁵ Calculated from Equation 17 of Table 4 in Ford (1985) and is the result of stepwise multiple regressions for length of historical coastline affected.

Source: USDO, MMS, Alaska OCS Region (2007).

Table A.1- 13 Identification Number (ID) and Name of Environmental Resource Areas, Represented in the Oil-Spill-Trajectory Model and Their Location on Environmental Resource Area Map A.1-2a, Map A.1-2b, Map A.1-2c, Map A.1-2d, or Map A.1-2e

ID	Environmental Resource Area Name	General Resource	Beaufort Map	Chukchi Map
1	Kasegaluk Lagoon	Birds, Whales, Barrier Island	A.1-2b	A.1-2b
2	Point Barrow, Plover Islands	Birds, Barrier Island	A.1-2a	A.1-2a
3	ERA 3	Subsistence		A.1-2a
4	ERA 4	Subsistence		A.1-2a
5	ERA 5	Subsistence		A.1-2a
6	ERA 6	Whales	A.1-2c	A.1-2c
7	US Russia Maritime Boundary	Russian Waters	A.1-2a	A.1-2a
8	Maguire, Flaxman Islands	Birds, Barrier Island	A.1-2e	A.1-2e
9	Stockton Islands, McClure Islands	Birds, Barrier Island	A.1-2e	A.1-2e
10	Ledyard Bay SPEI Critical Habitat Unit	Birds	A.1-2d	A.1-2d
11	Wrangel Island 12 nmi buffer	Marine Mammals	A.1-2a	A.1-2a
12	ERA 12	Whales	A.1-2d	
13	ERA 13	Subsistence, Whales, Marine Mammals		A.1-2a
14	Cape Thompson Seabird Colony Area	Birds	A.1-2d	A.1-2d
15	Cape Lisburne Seabird Colony Area	Birds, Marine Mammals	A.1-2c	A.1-2c
16	ERA 16	Whales		A.1-2a
17	Angun and Beaufort Lagoons	Birds, Barrier Island	A.1-2c	A.1-2c
18	Murre Rearing and Molting Area	Birds	A.1-2a	A.1-2a
19	Chukchi Spring Lead System	Whales, Birds	A.1-2a	A.1-2a
20	Ice/Sea Segment 7	Whales	A.1-2c	
21	Ice/Sea Segment 8	Whales	A.1-2c	
22	Ice/Sea Segment 9	Whales	A.1-2c	
23	Offshore Wrangel Island	Marine Mammals	A.1-2a	A.1-2a
24	Beaufort Spring Lead 6	Whales	A.1-2b	A.1-2b
25	Beaufort Spring Lead 7	Whales	A.1-2b	A.1-2b
26	Beaufort Spring Lead 8	Whales	A.1-2b	A.1-2b
27	Beaufort Spring Lead 9	Whales	A.1-2b	A.1-2b
28	Beaufort Spring Lead 10	Whales	A.1-2b	A.1-2b
29	Ice/Sea Segment 1	Whales	A.1-2c	A.1-2c
30	Ice/Sea Segment 2	Whales	A.1-2c	A.1-2c
31	Ice/Sea Segment 3	Whales	A.1-2c	A.1-2c
32	Ice/Sea Segment 4	Whales	A.1-2c	
33	Ice/Sea Segment 5	Whales	A.1-2c	
34	Ice/Sea Segment 6	Whales	A.1-2c	A.1-2c
35	ERA 35	Whales	A.1-2c	A.1-2c
36	ERA 36	Whales	A.1-2b	A.1-2b
37	ERA 37	Whales	A.1-2c	A.1-2c
38	Point Hope Subsistence Area	Subsistence	A.1-2a	A.1-2a
39	Point Lay Subsistence Area	Subsistence	A.1-2a	A.1-2a
40	Wainwright Subsistence Area	Subsistence	A.1-2a	A.1-2a
41	Barrow Subsistence Area 1	Subsistence	A.1-2a	A.1-2a
42	Barrow Subsistence Area 2	Subsistence	A.1-2a	A.1-2a
43	Nuiqsut Subsistence Area	Subsistence	A.1-2d	A.1-2d
44	Kaktovik Subsistence Area	Subsistence	A.1-2c	A.1-2c
45	ERA 45	Whales	A.1-2b	A.1-2b
46	Herald Shoal Polynya	Whales	A.1-2b	A.1-2b
47	Ice/Sea Segment 10	Marine Mammals	A.1-2b	A.1-2b
48	Ice/Sea Segment 11	Marine Mammals, Whales	A.1-2a	A.1-2a
49	ERA 49	Whales	A.1-2b	A.1-2b
50	Ice/Sea Segment 13	Marine Mammals	A.1-2a	A.1-2a

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ID	Environmental Resource Area Name	General Resource	Beaufort Map	Chukchi Map
51	Ice/Sea Segment 14	Marine Mammals	A.1-2a	A.1-2a
52	Ice/Sea Segment 15	Marine Mammals	A.1-2a	A.1-2a
53	Ice/Sea Segment 5a	Whales		A.1-2c
54	Ice/Sea Segment 6a	Whales		A.1-2c
55	Point Barrow, Plover Islands	Marine Mammals	A.1-2b	A.1-2b
56	ERA 56	Whales	A.1.2b	A.1.2b
57	Outer Kotzebue Sound	Marine Mammals		A.1.2a
58	Offshore Pt. Lay to Wainwright	Marine Mammals	A.1.2a	A.1.2a
59	Ostrov Kolyuchin	Marine Mammals		A.1.2a
60	King and Shingle Point	Subsistence	A.1-2d	
61	ERA 61	Whales		A.1.2a
62	Mackenzie River Estuary	Whales	A.1-2d	A.1-2d
63	ERA 63	Whales	A.1-2b	A.1-2b
64	Peard Bay Area	Birds	A.1-2d	A.1.2d
65	Smith Bay	Whales, Birds	A.1-2b	A.1-2b
66	Herald Island	Marine Mammals	A.1.2a	A.1.2a
67	Herschel Island (Canada)	Birds	A.1-2d	A.1-2d
68	Harrison Bay	Birds	A.1-2b	A.1-2b
69	Harrison Bay/Colville Delta	Birds	A.1-2b	A.1-2b
70	ERA 70	Whales	A.1.2b	A.1.2b
71	Simpson Lagoon, Thetis and Jones Island	Birds	A.1-2c	A.1-2c
72	Gwyder Bay, West Dock, Cottle and Return Islands	Birds	A.1-2c	A.1-2c
73	Prudhoe Bay	Birds	A.1-2c	A.1-2c
74	Offshore Herald Island	Whales	A.1.2a	A.1.2a
75	Water over Boulder Patch	Benthic	A.1-2c	A.1-2c
76	Kendall Island Bird Sanctuary (Canada)	Birds	A.1-2d	A.1-2d
77	Sagavanirktok River Delta/Foggy Island Bay	Birds	A.1-2c	A.1-2c
78	Mikkelsen Bay	Birds	A.1-2c	A.1-2c
79	Demarcation Bay Offshore	Birds	A.1-2d	A.1-2d
80	ERA 80	Whales	A.1-2c	A.1-2c
81	Simpson Cove	Birds	A.1-2c	A.1-2c
82	ERA 82	Whales		A.1.2a
83	Cape Schmidt	Whales		A.1.2a
84	Canning River Delta	Marine Fish - nearshore	A.1-2d	A.1-2d
85	Sagavanirktok River Delta	Marine Fish - nearshore	A.1-2d	A.1-2d
86	Harrison Bay	Marine Fish - nearshore	A.1-2b	A.1-2b
87	Colville River Delta	Marine Fish - nearshore	A.1-2b	A.1-2b
88	Simpson Lagoon	Marine Fish - nearshore	A.1-2b	A.1-2b
89	Mackenzie River Delta	Marine Fish - nearshore	A.1-2d	A.1-2d
90	Gary/Kendall	Subsistence	A.1-2d	
91	Hope Sea Valley	Whales		A.1.2a
92	Thetis, Jones, Cottle and Return Islands West Dock	Marine Mammals	A.1-2e	A.1-2e
93	Cross and No Name Island	Marine Mammals	A.1-2e	A.1-2e
94	Maguire Islands, Flaxman Island, Barrier Islands	Marine Mammals	A.1-2e	A.1-2e
95	Arey and Barter Islands and Bernard Spit	Marine Mammals	A.1-2e	A.1-2e
96	Midway, Cross and Bartlett Islands	Birds	A.1-2e	A.1-2e
97	Tigvariak Island	Subsistence	A.1-2e	A.1-2e
98	Anderson Point Barrier Islands	Birds	A.1-2e	A.1-2e
99	Arey and Barter Islands, Bernard Spit	Birds	A.1-2e	A.1-2e
100	Jago and Tapkaurak Spits	Birds	A.1-2e	A.1-2e
101	Icy Reef	Birds	A.1-2e	A.1-2e

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 14 Environmental Resource Areas Used in the Analysis of Large Oil Spill Effects on Birds.

ERA	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
1	x	x	Kasegaluk Lagoon	A.1-2b	May-October	Birds, barrier island	Birds: BLBR, LTDU, eiders (STEI, COEI), loons (PALO, RTLO, YBLO)	Lehnhausen and Quinlan, 1981; Johnson, 1993; Johnson, Wiggins, and Wainwright, 1993; Laing and Platte, 1994; Dau and Larned, 2004.
2	x	x	Point Barrow, Plover Islands	A.1-2a	May-October	Birds, barrier island	Birds: SPEI, LTDU	Troy, 2003; Fischer and Larned, 2004.
8	x	x	Maguire, Flaxman Islands	A.1-2c	May-October	Birds, barrier island	Birds: nesting COEI, molting LTDU, PALO	Johnson, Wiggins, and Wainwright, 1993; Johnson, 2000; Fischer and Larned, 2004; Flint et al., 2004; Johnson et al., 2005; Noel et al., 2005.
9	x	x	Stockton Islands, McClure Islands	A.1-2d	May-October	Birds, barrier island	Birds: nesting COEI, molting LTDU, staging SPEI	Johnson, Wiggins, and Wainwright, 1993; Johnson, 2000, Table 2; Troy, 2003; Fischer and Larned, 2004; Flint et al., 2004; Johnson et al., 2005; Noel et al., 2005.
10	x	x	Ledyard Bay SPEI Critical Habitat Unit	A.1-2d	July-November	Birds	Birds: seabirds, molting/staging SPEI, staging YBLO	66 FR 9146-9185; Laing and Platte, 1994; Petersen, Larned, and Douglas, 1999; Piatt and Springer, 2003.
14	x	x	Cape Thompson Seabird Colony Area	A.1-2d	May-October	Birds	Birds: seabirds, gulls, shorebirds, waterfowl, staging YBLO	Springer et al., 1984; Piatt et al., 1991; Piatt and Springer, 2003; Stephenson and Irons, 2003.
15	x	x	Cape Lisburne Seabird Colony Area	A.1-2c	May-October	Birds	Birds: seabird breeding colony, staging YBLO	Springer et al., 1984; Piatt et al., 1991; Roseneau et al., 2000; Piatt and Springer, 2003; Stephenson and Irons, 2003; Oppel, Dickson and Powell, 2009.
17	x	x	Angun and Beaufort Lagoons	A.1-2c	May-October	Birds, barrier island	Birds: molting LTDU, scoters, staging shorebirds	Johnson and Herter, 1989.
18	x	x	Murre Rearing and Molting Area	A.1-2a	May-October	Birds	Birds: Murre foraging, rearing, and molting area	Springer et al., 1984; Piatt and Springer, 2003.
19	x	x	Chukchi Sea Spring Lead System	A.1-2a	April-June	Birds, marine mammals	Birds: seabird foraging area; spring migration area for LTDU, eiders (KIEI, COEI), loons	Swartz, 1967; Connors, Myers, and Pitelka, 1979; SOWLS, Hatch, and Lensink., 1978; Gill, Handel, and Connors, 1985; Johnson and Herter, 1989; Piatt et al., 1991; Piatt and Springer, 2003; Oppel, Dickson and Powell, 2009.
64	x	x	Peard Bay Area	A.1-2d	May-July-October	Birds	Birds: eiders (SPEI, STEI, KIEI, COEI), loons (PALO, RTLO, YBLO)	Laing and Platte, 1994; Fischer and Larned, 2004.
65	x	x	Smith Bay	A.1-2b	May-October	Birds, marine mammals	Birds: eiders (SPEI, KIEI), loons YBLO	Earnst, et al., 2005; Powell, et al., 2005; Ritchie, Burgess, and Suydam, 2000; Ritchie et al., 2004; Troy, 2003.
67	x	x	Herschel Island (Canada)	A.1-2c	May-October	Birds	Birds: LTDU, BLBR, scoters, eiders, loons, shorebirds	Vermeer and Anweiler, 1975; Richardson and Johnson, 1981; Johnson and Richardson, 1982.

ERA	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
68	x	x	Harrison Bay	A.1-2b	May-October	Birds, fish, marine mammals	Birds: eiders (KIEI, COEI), scoters (BLSC, SUSC), geese (BLBR, CAGO, WFGO), loons, shorebirds	Connors, Connors, and Smith, 1984; Dau and Larned, 2004, 2005; Fischer and Larned, 2004.
69	x	x	Harrison Bay/Colville Delta	A.1-2b	May-October	Birds, fish, marine mammals	Birds: geese (BLBR), eiders (KIEI, COEI), LTDU, scoters (BLSC, SUSC), loons (PALO, RTLO, YBLO)	Bergman et al., 1977; Johnson and Herter, 1989; Dau and Larned, 2004, 2005; Fischer and Larned, 2004.
71	x	x	Simpson Lagoon, Thetis and Jones Island	A.1-2c	May-October	Birds, fish, marine mammals	Birds: geese (BLBR, LSGO, WFGO), eiders (COEI, KIEI), LTDU, scoters (SUSC, WWSC), shorebirds, loons (PALO, RTLO, YBLO)	Richardson and Johnson, 1981; Connors, Connors, and Smith., 1984; Divoky, 1984; Johnson, Herter, and Bradstreet, 1987; Johnson and Herter, 1989; Stickney and Ritchie, 1996; Noel and Johnson, 1997; Truett, Miller and Kertell, 1997; Johnson, 2000.
72	x	x	Gwyder Bay, West Dock, Cottle and Return Islands	A.1-2c	May-October	Birds, fish, marine mammals	Birds: geese (BLBR, LSGO, WFGO), eiders (COEI, KIEI), LTDU, scoters (SUSC, WWSC), shorebirds, loons (PALO, RTLO, YBLO)	Stickney and Ritchie, 1996; Noel and Johnson, 1997; Truett, Miller, and Kertell, 1997; Johnson, 2000; Troy, 2003; Fischer and Larned, 2004; Noel et al., 2005; Powell et al., 2005.
73	x	x	Prudhoe Bay	A.1-2c	May-October	Birds, fish, marine mammals	Birds: geese (BLBR, LSGO, WFGO), eiders (COEI, KIEI), LTDU, scoters (SUSC, WWSC), shorebirds, loons (PALO, RTLO, YBLO)	Richardson and Johnson, 1981; Johnson and Richardson, 1982; Stickney and Ritchie, 1996; Noel and Johnson, 1997; Truett, Miller, and Kertell, 1997; Troy, 2003; Dau and Larned, 2004, 2005; Fischer and Larned, 2004; Noel et al., 2005; Powell et al., 2005.
76	x	x	Kendall Island Bird Sanctuary (Canada)	A.1-2d	May-October	Birds	Birds: eiders (KIEI, COEI), LTDU, scoters (all 3 species), loons (PALO, RTLO, YBLO)	Divoky, 1984; Richardson and Johnson, 1981; Johnson and Richardson, 1982; Alexander, Dickson, and Westover, 1997; Dickson et al., 1997.
77	x	x	Sagavanirktok River Delta /Foggy Island Bay	A.1-2c	May-October	Birds	Birds: eiders SPEI, COEI, LTDU, scoters (all 3 species), loons (PALO, RTLO, YBLO)	Divoky, 1984; Johnson, 2000; Troy, 2003; Dau and Larned, 2004, 2005; Fischer and Larned, 2004; Johnson, Wiggins, and Wainwright, 1993.
78	x	x	Mikkelsen Bay	A.1-2c	May-October	Birds	Birds: eiders (KIEI, COEI), LTDU, scoters, loons (PALO, RTLO)	Divoky, 1984; Johnson, 2000; Troy, 2003; Dau and Larned, 2004, 2005; Fischer and Larned, 2004; Flint et al., 2004; Noel et al., 2005.
79	x	x	Demarcation Bay Offshore	A.1-2c	May-October	Birds	Birds: eiders (KIEI, COEI), LTDU, scoters (SUSC, WWSC), loons	Richardson and Johnson, 1981; Johnson and Richardson, 1982; Johnson and Herter, 1989; Dau and Larned, 2004, 2005; Fischer and Larned, 2004.
81	x	x	Simpson Cove	A.1-2c	May-October	Birds	Birds: COEI, LTDU, PALO, scoters (SUSC, WWSC)	Johnson and Herter, 1989; Dau and Larned, 2004; 2005; Fischer and Larned, 2004.
96	x	x	Midway, Cross and Bartlett Islands	A.1-2e	May-October	Birds	Birds: Eiders (SPEI,COEI), LTDU, Scoters (all 3 species), and loons (PALO,RTLO,YBLO)	Divoky, 1984; Johnson, 2000; Troy, 2003 fig 3.; Dau and Larned, 2004, 2005; Fischer and Larned, 2004.
98	x	x	Anderson Point Barrier Islands	A.1-2e	May-October	Birds	Birds: Eiders (SPEI,COEI), LTDU, Scoters (all 3 species), and loons (PALO,RTLO,YBLO)	Divoky, 1984; Johnson, 2000; Troy, 2003 fig 3.; Dau and Larned, 2004, 2005; Fischer and Larned, 2004.

ERA	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
99	x	x	Arey and Barter Islands, Bernard Spit	A.1-2e	May-October	Birds	Birds: Eiders (SPEI,COEI), LTDU, Scoters (all 3 species), and loons (PALO,RTLO,YBLO)	Divoky, 1984; Johnson, 2000; Troy, 2003 fig 3.; Dau and Larned, 2004, 2005; Fischer and Larned, 2004.
100	x	x	Jago and Tapkaurak Spits	A.1-2e	May-October	Birds	Birds: Eiders (SPEI,COEI), LTDU, Scoters (all 3 species), and loons (PALO,RTLO,YBLO)	Divoky, 1984; Johnson, 2000; Troy, 2003 fig 3.; Dau and Larned, 2004, 2005; Fischer and Larned, 2004.
101	x	x	Icy Reef	A.1-2e	May-October	Birds	Birds: molting LTDU, scoters, staging shorebirds	Johnson and Herter, 1989.

Notes: Yellow-billed Loon (YBLO), Red-throated Loon (RTLO), Pacific Loon (PALO), Arctic Loon (ARLO), COEI (Common Eider), KIEI (King Eider), SPEI (Spectacled Eider), STEI (Steller's Eider), LTDU (Long-tailed Duck), Black Scoter (BLSC), Surf Scoter (SUSC), White-winged Scoter (WWSC), Black Brant (BLBR), White-fronted Goose (WFGO), Canada Goose (CAGO), Lesser Snow Goose (LSGO)

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 15 Environmental Resource Areas Used in the Analysis of Large Oil Spill Effects on Whales .

ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
1	x	x	Kasegaluk Lagoon	A.1-2b	May - October	Whales	Beluga Whales	Suydam et al., 2001; Suydam, Lowry, and Frost, 2005.
6	x	x	ERA 6	A.1-2c	April-October	Whales	Bowhead Whales	Mel'nikov et al., 2004.
12	x	x	ERA 12	A.1-2d	April-June	Whales	Bowhead Whales	Ljungblad, D.K. et al., 1986.
13		x	Kotzebue Sound	A.1-2a	January-December	Whales	Beluga Whales	Suydam et al., 2001; Suydam, Lowry, and Frost, 2005.
16		x	ERA 16	A.1-2b	June-September	Whales	Bowhead Whales, Gray Whales	Mel'nikov and Bobkov, 1993; Bogoslovskaya, Votrogov, and Krupnik, 1982.
19	x	x	Chukchi Sea Spring Lead System	A.1-2a	April-June	Whales, Birds, Marine Mammals	Bowhead Whales, Gray Whales	Stringer and Groves, 1991; Ljungblad, D.K. et al., 1986.
20	x		Ice/Sea Segment 7	A.1-2c	September-October	Whales, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
21	x		Ice/Sea Segment 8	A.1-2c	September-October	Whales, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
22	x		Ice/Sea Segment 9	A.1-2c	September-October	Whales,	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.

ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
24	x	x	Beaufort Spring Lead 6	A.1-2b	April-June	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986.
25	x	x	Beaufort Spring Lead 7	A.1-2b	April-June	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986.
26	x	x	Beaufort Spring Lead 8	A.1-2b	April-June	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986.
27	x	x	Beaufort Spring Lead 9	A.1-2b	April-June	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986.
28	x	x	Beaufort Spring Lead 10	A.1-2b	April-June	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986.
29	x	x	Ice/Sea Segment 1	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
30	x	x	Ice/Sea Segment 2	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
31	x	x	Ice/Sea Segment 3	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
32	x	x	Ice/Sea Segment 4	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
33	x		Ice/Sea Segment 5	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
34	x		Ice/Sea Segment 6	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
35	x	x	ERA 35	A.1-2c	August-October	Whales	Bowhead Whales	Ljungblad, D.K. et al., 1986.
36	x	x	ERA 36	A.1-2c	August-October	Whales	Bowhead Whales	Ljungblad, D.K. et al., 1986.
37	x	x	ERA 37	A.1-2c	April-June	Whales	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
45	x	x	ERA 45	A.1-2b	April-October	Whales	Bowhead Whales	Ljungblad, D.K. et al., 1986.
46	x	x	Herald Shoal and Polynya	A.1-2a	April-November	Whales, Marine mammals,	Gray Whales, Bowhead whales	Stringer and Groves, 1991.

ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
48	x	x	Ice/Sea Segment 11	A1-2b	May-October	Whales	Bowhead Whales , Gray Whales, Walrus	Moore and DeMaster, 1997.
49	x	x	ERA 49	A.1-2a	July-October	Whales		Ljungblad, D.K. et al., 1986; Stringer and Groves 1991.
53		x	Ice/Sea Segment 5a	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
54		x	Ice/Sea Segment 6a	A.1-2c	September-October	Whales, Birds, Marine Mammals	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
56	x	x	ERA 56	A.1-2b	August-October	Whales	Bowhead Whales	Ljungblad, D.K. et al., 1986.
61		x	ERA 61	A.1-2b	April-December	Whales	Bowhead, Fin and Humpback Whales	Mel'nikov, 2000; Mel'nikov and Bobkov, 1993; Mel'nikov, et al., 2004; USDOC, NMFS, 2006; Rice, 1974, Bogoslovskaya, Votrogov, and Krupnik, 1982; Marquette et al., 1982; Mizroch et al, 2009; Mizroch, Rice and Breiwick, 1984; Angliss and Outlaw 2005; 2007.
62	x	x	Mackenzie River Estuary	A.1-2d	July	Whales	Beluga Whales	Harwood et al, 1996.
63	x	x	ERA 63	A.1-2a	July-October	Whales	Bowhead Whales	
65	x	x	Smith Bay	A.1-2b	May-October	Whales, Birds	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
70	x	x	ERA 70	A.1-2a	July-October	Whales	Bowhead Whales	
74	x	x	Offshore Herald Island	A.1-2a	August-October	Whales, Polar Bears, Walrus	Bowhead Whales	Bogoslovskaya et al. 1982.
80	x	x	ERA 80	A.1-2c	April-June	Whales	Bowhead Whales	Ljungblad, D.K. et al., 1986; Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002; Monnett and Treacy, 2005.
82		x	ERA 82	A.1-2a	September	Whales	Bowhead whales	Mel'nikov and Bobkov, 1993; Bogoslovskaya, Votrogov, and Krupnik, 1982.
83		x	Cape Schmidta	A.1-2a	August-October	Whales	Bowhead Whales	Bogoslovskaya, Votrogov, and Krupnik, 1982.
91		x	Hope Sea Valley	A.1-2a	August-October	Whales	Bowhead Whales	Bogoslovskaya, Votrogov, and Krupnik, 1982.

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 16 Environmental Resource Areas Used in the Analysis of Large Oil Spill Effects on Subsistence Resources.

ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
3		x	ERA 3	Map A.1-2a	September-October	Subsistence	Bowhead Whales, Grey Whales, Walrus	Mel'nikov and Bobkov, 1993.
4		x	ERA 4	Map A.1-2a	January-December	Subsistence	Bowhead Whales, Grey Whales, Walrus	Mel'nikov and Bobkov, 1993.
5		x	ERA 5	Map A.1-2a	April-September	Subsistence	Polar Bears, Walrus, Seals	Sobelman, 1985; Wisniewski, 2005.
13		x	ERA 13	Map A.1-2a	January-December	Subsistence	Polar Bears, Walrus, Seals, Bowhead Whales, Beluga Whales	Burch, 1985.
38	x	x	Point Hope Subsistence Area	Map A.1-2a	January-December	Subsistence	Beluga Whales, Bowhead Whales, Walrus, Seals	Braund & Burnham, 1984.
39	x	x	Point Lay Subsistence Area	Map A.1-2a	January-December	Subsistence	Fish, Seals, Waterfowl, Beluga Whales	Braund & Burnham, 1984; Impact Assessment, 1989; Huntington and Mymrin, 1996; USDOI, BLM and MMS, 2003.
40	x	x	Wainwright Subsistence Area	Map A.1-2a	January-December	Subsistence	Bowhead Whales, Beluga Whales	Braund and Burnham, 1984; S.R. Braund and Assocs., 1993a, Kassam and Wainwright Traditional Council, 2001; USDOI, BLM and MMS, 2003.
41	x	x	Barrow Subsistence Area 1	Map A.1-2a	April-May	Subsistence	Bowhead Whales, Beluga Whales, Walrus, Waterfowl, Seals, Ocean Fish	Braund and Burnham, 1984; S.R. Braund and Assocs., 1993b; North Slope Borough, 2001; USDOI, BLM and MMS, 2003.
42	x	x	Barrow Subsistence Area 2	Map A.1-2a	August-October	Subsistence	Bowhead Whales, Beluga Whales, Walrus, Waterfowl, Seals, Ocean Fish	Braund and Burnham, 1984; S.R. Braund and Assocs., 1993b; North Slope Borough, 2001; USDOI, BLM and MMS, 2003.
43	x	x	Nuiqsut Subsistence Area	Map A.1-2d	August-October	Subsistence	Bowhead Whales, Seals, Waterfowl, Ocean Fish	Impact Assessment, 1990a; USDOI, MMS, 2001; North Slope Borough, 2001.
44	x	x	Kaktovik Subsistence Area	Map A.1-2c	August-October	Subsistence	Bowhead Whales, Seals, Walrus, Beluga Whales, Waterfowl, Ocean Fish	Impact Assessment, 1990b; North Slope Borough, 2001.
60	x		King and Shingle Point	Map A.1-2d	April-September	Subsistence	Polar Bears, Seals, Fish, Bowhead Whales, Beluga Whales	Environment Canada, 2000.
90	x		Gary/Kendall	Map A.1-2d	July-August	Subsistence	Beluga Whales	Environment Canada, 2000.
97	x		Tigvariak Island	Map A.1-2e	May-October	Subsistence, Birds	Traditional Whaling Area	Pedersen, 1979.

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 17 Environmental Resource Areas, Grouped Land Segments and Land Segments Used in the Analysis of Oil Spill Effects on Marine Mammals.

ERA, LS or GLS ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
11	x	x	Wrangel Island 12 nmi buffer	A.1-2a	July - November	Marine Mammals	Polar Bears, Walrus	Kochnev, 2002; Kochnev et al., 2003; Kochnev, 2006; Fay, 1982.
15	x	x	Cape Lisburne	A.1-2c	May-October	Marine Mammals	Walrus	Garlich-Miller, 2007, pers. commun.; Fay, 1982.
23	x	x	Offshore Wrangel Island	A.1-2a	July-November	Marine Mammals	Walrus	Fay, 1982; Jay, 2007, pers. commun.
47	x	x	Ice/Sea Segment 10	A.1-2d	May-October	Marine Mammals	Walrus	Fay, 1982; Jay, 2007, pers. commun.
48	x	x	Ice/Sea Segment 11	A.1-2a	May-October	Marine Mammals	Walrus	Fay, 1982; Jay, 2007, pers. commun.
50	x	x	Ice/Sea Segment 13	A.1-2a	May-October	Marine Mammals	Walrus	Fay, 1982; Jay, 2007, pers. commun.
51	x	x	Ice/Sea Segment 14	A.1-2a	May-October	Marine Mammals	Walrus	Fay, 1982; Jay, 2007. pers. commun.
52	x	x	Ice/Sea Segment 15	A.1-2a	May-October	Marine Mammals	Walrus	Fay, 1982; Jay, 2007. pers. commun.
55	x	x	Point Barrow, Plover Islands	A.1-2a	August-November	Marine Mammals	Polar Bears	Evans, 2008, pers. commun.
57		x	Outer Kotzebue Sound	A.1-2b	May-June	Marine Mammals	Walrus	Fay, 1982; Jay, 2007, pers. commun.
58	x	x	Offshore Pt. Lay to Wainwright	A.1-2a	May-October	Marine Mammals	Walrus	Fay, 1982; Jay, 2007, pers. commun.
59		x	Ostrov Kolyuchin	A.1-2a	July -November	Marine Mammals	Polar Bears, Walrus	Kochnev et al., 2003; Kochnev, 2006; Fay, 1982.
66	x	x	Herald Island	A.1-2a	July-November	Marine Mammals	Polar Bears, Walrus	Ovsyanikov,1998; Stishov, 1991, Fay, 1982; Jay, 2007, pers. com.
92	x	x	Thetis, Jones, Cottle & Return Isl.	A.1-2e	January-December	Marine Mammals	Polar Bears (den)	Evans, 2008, pers. commun.
93	x	x	Cross and No Name Island	A.1-2e	August-November	Marine Mammals	Polar Bears	Evans, 2008, pers. commun., Miller, Schliebe, and Proffitt, 2006.
94	x	x	Maguire, Flaxman & Barrier Isl.	A.1-2e	January-December	Marine Mammals	Polar Bears (den)	Evans, 2008, pers. commun.

ERA, LS or GLS ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
95	x	x	Arey & Barter Island, Bernard Spit	A.1-2e	August-November	Marine Mammals	Polar Bears	Miller, Schliebe, and Proffitt, 2006.
GLS 127		x	Mys Blossom,	A.1-3d	July-November	Marine Mammals	Walrus	Ovsyanikov, 2003; Kochnev, 2004; Kochnev, 2006; Garlich-Miller, 2007, pers. commun.; Fay, 1982.
GLS128		x	Bukhta Somnitel'naya	A.1-3d	July-November	Marine Mammals	Polar Bears, Walrus	Ovsyanikov, 2003; Kochnev, 2004; Kochnev, 2006; Garlich-Miller, pers. commun.; Fay, 1982.
LS 28		x	Ostrov Karkarko, Mys Vankarem,	A.1-3d	July-November	Marine Mammals	Walrus	Kochnev, 2004; Fay, 1982.
LS 29		x	Mys Onmyn,	A.1-3d	July-November	Marine Mammals	Walrus	Kochnev, 2004; Fay, 1982.
GLS 129		x	Ostrov Idlidlya,	A.1-3d	July-November	Marine Mammals	Walrus	Kochnev, 2004; Fay, 1982.
GLS 130		x	Mys Serditse Kamen	A.1-3d	July- November	Marine Mammals	Walrus	Kochnev, 2004; Fay, 1982.
LS 38		x	Mys Unikin,	A.1-3a	July-November	Marine Mammals	Walrus	Kochnev, 2004 Fay, 1982.
LS 39		x	Mys Dezhnev, Mys Peek, Cape Peek	A.1-3a	July- November	Marine Mammals	Walrus	Kochnev, 2004 Fay, 1982;.
LS 48	x	x	Cape Espenberg	A.1-3b	July-October	Marine Mammals	Spotted Seal	Frost, Lowry, and Carroll, 1992.
GLS 134		x	Cape Lisburne	A.1-3b	August-November	Marine Mammals	Walrus	Garlich-Miller, 2007, pers. commun.; Fay, 1982.
LS 85	x	x	Barrow, Browerville, Elson Lagoon	A.1-3b	August-November	Marine Mammals	Polar Bears	Evans, 2008. pers. commun.
GLS 142		x	Russian Coastline	A.1-3d	July-November	Marine Mammals	Polar Bears, Walrus	Kochnev, 2006

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 18 Environmental Resource Areas and Land Segments Used in the Analysis of Large Oil Spill Effects on Fish.

ERA/LS ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
			Marine Waters					
ERA 84	x	x	Canning River Delta	A.1-2d	January - December	Marine Fish – nearshore	Arctic cod, Fourhorn sculpin, Capelin	Jarvela and Thorsteinson, 1998.
ERA 85	x	x	Sagavanirktok River Delta ERA	A.1-2d	January - December	Marine Fish – nearshore	Arctic cod, Fourhorn sculpin, Capelin	Jarvela and Thorsteinson, 1998; Craig, 1984.
ERA 86	x	x	Harrison Bay	A.1-2b	January - December	Marine Fish – nearshore	Arctic cod, Capelin, OM, Saffron cod Fourhorn sculpin, Wp	Jarvela and Thorsteinson, 1998; Craig, 1984.
ERA 87	x	x	Colville River Delta	A.1-2b	January - December	Marine Fish – nearshore	Arctic cod, Capelin, OM, Saffron cod Fourhorn sculpin, Wp	Jarvela and Thorsteinson, 1998; Craig, 1984.
ERA 88	x	x	Simpson Lagoon	A.1-2b	January- December	Marine Fish – nearshore	Arctic cod, Capelin, OM, Saffron cod Fourhorn sculpin, Wp	Jarvela and Thorsteinson, 1998; Craig, 1984.
ERA 89	x	x	Mackenzie River Delta	A.1-2d	January - December	Marine Fish – nearshore	Arctic cod, Wp, Fourhorn sculpin	Craig, 1984.
			Russia					
LS 25	x	x	Amguema River	A.1-3a	May - October	Anadromous Fish	CHs,Ps,ALp,DVs,ACs,Kp,Sp,COp,Ws, OMp	Andreev, 2001.
LS 31	x	x	Kolyuchinskaya Bay	A.1-3a	May - October	Anadromous Fish	Ps,Ks,DVs,ACs,Wp,OMp	Andreev, 2001.
LS 37	x	x	Chegitun R.	A.1-3a	May - October	Anadromous Fish	Bering Cisco,ACs,DVs,Ps,Ks,CHs,Ss, OMp	Andreev, 2001.
LS 38	x	x	Inchoun Lagoon	A.1-3a	May - October	Anadromous Fish	CHp,Pp,Kp,COp,Sp,Bering Cisco, Least Cisco	Andreev, 2001.
LS 39	x	x	Uelen Lagoon	A.1-3a	May - October	Anadromous Fish	CHp,Pp,Kp,COp,Sp,Bering Cisco, Least Cisco	Andreev, 2001.
			United States					
LS 40	x	x	Mint R	A.1-3b	May - October	Anadromous Fish	CHs,Ps,Sp,DVpr	Johnson and Weiss, 2007.
LS 41	x	x	Pinguk R	A.1-3b	May - October	Anadromous Fish	CHs,Pp,DVp,Wp	Johnson and Weiss, 2007.

ERA/LS ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
LS 42	x	x	Upkuarok Ck, Nuluk R. Kugrupaga R. Trout Ck.	A.1-3b	May - October	Anadromous Fish	DVpr CHs,Ps,DVp,Wp DVp DVpr,Wp	Johnson and Weiss, 2007.
LS 43	x	x	Shishmaref Airport	A.1-3b	May - October	Anadromous Fish	DVp	Johnson and Weiss, 2007.
LS 44	x	x	Shishmaref Inlet Arctic R. Sanaguich R Serpentine R	A.1-3b	May - October	Anadromous Fish	DVp,SFp,Wp DVp,SFp,Wp DVp CHp,DVp,SFp,Wp	Johnson and Weiss, 2007.
LS 47	x	x	Kitluk R	A.1-3b	May - October	Anadromous Fish	Pp	Johnson and Weiss, 2007.
LS 49	x	x	Kougachuk Ck	A.1-3b	May - October	Anadromous Fish	Pp	Johnson and Weiss, 2007.
LS 51	x	x	Inmachuk R Kugruk R	A.1-3b	May - October	Anadromous Fish	CHs,Ps,DVp CHp,Pp,DVp	Johnson and Weiss, 2007.
LS 53	x	x	Kiwalik R Buckland R	A.1-3b	May - October	Anadromous Fish	CHp,Pp,DVp CHp,COp,Kp,Pp,DVp,Wp	Johnson and Weiss, 2007.
LS 54	x	x	Baldwin Penn Kobuk R & Channels	A.1-3b	May - October	Anadromous Fish	DVp,DVs CHp,Kp,Pp,DVs,SFp,Wp	Johnson and Weiss, 2007.
LS 55	x	x	Hotham Inlet Ogriveg R	A.1-3b	May - October	Anadromous Fish	CHp,Pp,DVs,Wp CHp,Pp,DVp	Johnson and Weiss, 2007.
LS 56	x	x	Noatak R	A.1-3b	May - October	Anadromous Fish	CHp,COp,Kp,Pp,Sp,DVp,SFp,Wpr	Johnson and Weiss, 2007.
LS 57	x	x	Aukulak Lagoon	A.1-3b	May - October	Anadromous Fish	Wp	Johnson and Weiss, 2007.
LS 58	x	x	Tasaychek Lagoon	A.1-3b	May - October	Anadromous Fish	Pp	Johnson and Weiss, 2007.
LS 59	x	x	Kiligmak Inlet Jade Ck Rabbit Ck Imik Lagoon New Heart Ck Omikviorok R	A.1-3b	May - October	Anadromous Fish	DVp,Wp DVp CHp,Sp,DVp Wp DVr DVp,Wp	Johnson and Weiss, 2007.
LS 60	x	x	Imikruk Lagoon Wulik R Kivalina R	A.1-3b	May - October	Anadromous Fish	Wp CHp,COp,Kp,Pp,Sp,DVs,Wp CHp,CHs,Pp,DVp	Johnson and Weiss, 2007.

ERA/LS ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
LS 64	x	x	Sulupoaktak Chnl	A.1-3b	May - October	Anadromous Fish	Pp,DVp	Johnson and Weiss, 2007.
LS 67	x	x	Pitmegea R	A.1-3b	May - October	Anadromous Fish	CHp,Pp,DVp	Johnson and Weiss, 2007.
LS 70	x	x	Kuchiak Ck	A.1-3b	May - October	Anadromous Fish	CHs,COs	Johnson and Weiss, 2007.
LS 71	x	x	Kukpowruk R	A.1-3b	May - October	Anadromous Fish	CHp,Pp,DVp	Johnson and Weiss, 2007.
LS 72	x	x	Pt Lay ,Kokolik R	A.1-3b	June - October	Anadromous Fish	CHp,Pp,DVp	Johnson and Weiss, 2007.
LS 74	x	x	Utukok R	A.1-3b	June - October	Anadromous Fish	CHp,Pp,DVp	Johnson and Weiss, 2007.
LS 80	x	x	Kugrua R	A.1-3b	June - October	Anadromous Fish	CHs,Ps	Johnson and Weiss, 2007.
LS 87	x	x	Inaru R Meade R Topagoruk R Chipp R	A.1-3c	June - October	Anadromous Fish	Wsr CHs,Wp Wsr Ps,Wsr	Johnson and Weiss, 2007.
LS 89	x	x	Ikpikpuk R	A.1-3c	June - October	Anadromous Fish	Psr,Wsr	Johnson and Weiss, 2007.
LS 91	x	x	Smith R	A.1-3c	June - October	Anadromous Fish	DVp,Wp	Johnson and Weiss, 2007.
LS 93	x	x	Kalikipik R	A.1-3c	June - October	Anadromous Fish	Wp	Johnson and Weiss, 2007.
LS 94	x	x	Fish Ck Nechelik Channel	A.1-3c	June - October	Anadromous Fish	CHp,Kp,Pp,DVp,Wp Wp	Johnson and Weiss, 2007.
LS 95	x	x	Colville R & Delta	A.1-3c	June - October	Anadromous Fish	CHp,Pp,DVp,Wp	Johnson and Weiss, 2007.
LS 96	x	x	Kalubik R Ugnuravik R	A.1-3c	June - October	Anadromous Fish	DVp,Wp Wr	Johnson and Weiss, 2007.
LS 97	x	x	Oogrukpu R Sakonowayak R	A.1-3c	June - October	Anadromous Fish	Wpr Wr	Johnson and Weiss, 2007.
LS 98	x	x	Kuparuk R Fawn Ck Unnamed 10435 Putuligayuk R	A.1-3c	June - October	Anadromous Fish	Wr Wp DVr DVr,OMp,Wr	Johnson and Weiss, 2007.

ERA/LS ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
LS 99	x	x	Sagavanirktok R E. Sagavanirktok Ck	A.1-3c	June - October	Anadromous Fish	ACp,Chp,Pp,DVr,Wp DVr	Johnson and Weiss, 2007.
LS 100	x	x	Kadleroshilik R Shavirovik R 10300	A.1-3c	June - October	Anadromous Fish	DVr DVp DVr	Johnson and Weiss, 2007.
LS 101	x	x	E Badami Ck 10280(AWC#)	A.1-3c	June - October	Anadromous Fish	DVr DVr	Johnson and Weiss, 2007.
LS 102	x	x	10246(AWC#) 10238(AWC#) 10234(AWC#) Staines R	A.1-3c	June - October	Anadromous Fish	DVr DVr DVr Pp,DVp,Wp	Johnson and Weiss, 2007.
LS 103	x	x	W. Canning R Canning R Tamayariak R	A.1-3c	June - October	Anadromous Fish	Pp,DVp,Wp CHp,Pp,DVp,Wp DVr	Johnson and Weiss, 2007.
LS 104	x	x	Katakturik R 10193(AWC#)	A.1-3c	June - October	Anadromous Fish	DVp DVr	Johnson and Weiss, 2007.
LS 105	x	x	Marsh Ck Carter Ck	A.1-3c	June - October	Anadromous Fish	DVr DVr	Johnson and Weiss, 2007.
LS 106	x	x	ERA 44,83 (193) Nataroarok Ck Hulahula R Okpilak R 10173(AWC#)	A.1-3c	June - October	Anadromous Fish	DVr DVp DVp DVr	Johnson and Weiss, 2007.
LS 107	x	x	Jago R	A.1-3c	June - October	Anadromous Fish	DVp	Johnson and Weiss, 2007.
LS 108	x	x	Kimikpaurak R	A.1-3c	June - October	Anadromous Fish	DVr	Johnson and Weiss, 2007.
LS 109	x	x	Siksik R Sikrelurak R Angun R 10150-2004(AWC#) Kogotpak 10140-2006(AWC#)	A.1-3c	June - October	Anadromous Fish	DVr DVr DVr DVr DVp DVr	Johnson and Weiss, 2007.
LS 110	x	x	Aichilik R Egaksrak R Kongakut R	A.1-3c	June – October	Anadromous Fish	DVp DVp DVp	Johnson and Weiss, 2007.
			Canada	A.1-3c				
LS 112	x	x	Fish R.	A.1-3c	June - October	Anadromous Fish	ACp, Wp	Craig, 1984; Kendel et al., 1974.

ERA/LS ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
LS 113	x	x	Malcolm R	A.1-3c	June - October	Anadromous Fish	ACp, OMp	Craig, 1984.
LS 114	x	x	Firth R.	A.1-3c	June - October	Anadromous Fish	ACp,OMp	Craig, , 1984.
LS 116	x	x	Spring R.	A.1-3c	June - October	Anadromous Fish	ACp,Wp,SFp,OMp	Craig, 1984.
LS 117	x	x	Babbage R	A.1-3c	June - October	Anadromous Fish	ACp,Wp	Craig, 1984.
LS 119	x	x	Blow R	A.1-3c	June - October	Anadromous Fish	ACp,Wp,SFp	Craig, 1984.
LS 122-126	x	x	Mackenzie River	A.1-3c	June - October	Anadromous Fish	ACpWp,CHp,OMp,SFp	Craig, 1984.

Key:

AC	Arctic Char	CO	Coho salmon	S	Sockeye salmon	p	present
AL	Arctic lamprey	DV	Dolly Varden	SF	Sheefish	r	rearing
K	Chinook salmon	P	Pink salmon	W	Whitefish (undifferentiated)		
CH	Chum salmon	OM	Rainbow smelt	s	spawning		

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 19 Environmental Resource Areas Used in the Analysis of Large Oil Spill Effects on Lower Trophic Level Organisms

ID	BEAU	CHU	NAME	MAP	VULNERABLE	GENERAL RESOURCE	SPECIFIC RESOURCE	REFERENCE
7	x	x	US Russia Maritime Boundary	A.1-2a	January-December	Lower Trophic Level Organisms	International Russian Waters	U.S. Dept. of State, 1990.
75	x	x	Water over Boulder Patch	A.1-2c	July through September	Lower Trophic Level Organisms	Kelp	Dunton, Reimnitz, and Schonberg, 1982; Coastal Frontiers Corporation, 1998; LGL Ecological Research Associates, Inc. 1998.

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 20 Land Segment ID and the Geographic Place Names within the Land Segment.

ID	Geographic Place Names	ID	Geographic Place Names
1	Mys Blossom, Mys Fomy, Khishchnikov, Neozhidannaya, Laguna Vaygan	36	Mys Chechan, Mys Ikigur, Keniskhvik, Mys Serditse Kamen
2	Mys Gil'der, Ushakovskiy, Mys Zapadnyy	37	Chegitun, Utkan, Mys Volnistyy
3	Mys Florens, Gusinaya	38	Enmytagyn, Inchoun, Inchoun, Laguna Inchoun, Mitkulino, Uellen, Mys Unikyn
4	Mys Ushakova, Laguna Drem-Khed	39	Cape Dezhnev, Mys Inchoun, Naukan, Mys Peek, Uelen, Laguna Uelen, Mys Uelen
5	Mys Evans, Neizvestnaya, Bukhta Pestsonaya	40	Ah-Gude-Le-Rock, Dry Creek, Lopp Lagoon, Mint River
6	Ostrov Mushtakova	41	Ikpek, Ikpek Lagoon, Pinguk River, Yankee River
7	Kosa Bruch	42	Arctic Lagoon, Kugrupaga Inlet, Nuluk River
8	Klark, Mys Litke, Mys Pillar, Skeletov, Mys Uering	43	Sarichef Island, Shishmaref Airport
9	Nasha, Mys Proletarskiy, Bukhta Rodzhers	44	Cape Lowenstern, Egg Island, Shishmaref, Shishmaref Inlet
10	Reka Berri, Bukhta Davidova, , Khishchnika, Reka Khishchniki	45	
11	Bukhta Somnitel'naya	46	Cowpack Inlet, Cowpack River, Kalik River, Kividlo, Singeak, Singeakpuk River, White Fish Lake
12	Zaliv Krasika, Mamontovaya, Bukhta Predatel'skaya	47	Kitluk River, Northwest Corner Light, West Fork Espenberg River
13	Mys Kanayen, Mys Kekurnyy, Mys Shalaurova, Veyeman	48	Cape Espenberg, Espenberg, Espenberg River
14	Innukay, Laguna Innukay, Umkuveyem, Mys Veuman	49	Kungealoruk Creek, Kougachuk Creek, Pish River
15	Laguna Adtaynung, Mys Billingsa, Ettam, Gytshelen, Laguna Uvargina	50	Clifford Point, Cripple River, Goodhope Bay, Goodhope River, Rex Point, Sullivan Bluffs
16	Mys Emmatagen, Mys Enmytagyn, Uvargin	51	Cape Deceit, Deering, Kugruk Lagoon, Kugruk River, Sullivan Lake, Toawlevic Point
17	Enmaat'khyr, Kenmankautir, Mys Olennyy, Mys Yakan, Yakanvaam, Yakan	52	Motherwood Point, Ninemile Point, Willow Bay
18	Mys Enmykay, Laguna Olennaya, Pil'khikay, Ren, Rovaam, Laguna Rypil'khin	53	Kiwalik, Kiwalik Lagoon, Middle Channel Kiwalk River, Minnehaha Creek, Mud Channel Creek, Mud Creek
19	Laguna Kuepil'khin, Leningradskiy	54	Baldwin Peninsula, Lewis Rich Channel
20	Polyarnyy, Kuekvun', Notakatrny, Pil'gyn, Tynupytku	55	Cape Blossom, Pipe Spit
21	Laguna Kinmanyakicha, Laguna Pil'khikay, Amen, Pil'khikay, Bukhta Severnaya, Val'korkey	56	Kinuk Island, Kotzebue, Noatak River
22	Ekiatan', Laguna Ekiatan, Kelyun'ya, Mys Shmidta, Rypkarpyy	57	Aukulak Lagoon, Igisukruk Mountain, Noak, Mount, Sheshalik, Sheshalik Spit
23	Emuem, Kemuem, Koyvel'khveyergin, Laguna Tengergin, Tenkergin	58	Cape Krusenstern, Eigeloruk, Evelukpalik River, Kasik Lagoon, Krusenstern Lagoon,
24		59	Imik Lagoon, Ipiavik Lagoon, Kotlik Lagoon, Omikviorok River
25	Laguna Amguema, Ostrov Leny, Yulinu	60	Imikruk Lagoon, Imnakuk Bluff, Kivalina, Kivalina Lagoon, Singigrak Spit, Kivalina River, Wulik River
26	Ekugvaam, Reka Ekugvam, Kepin, Pil'khin	61	Asikpak Lagoon, Cape Seppings, Kavrorak Lagoon, Pusaluk Lagoon, Seppings Lagoon
27	Laguna Nut, Rigol'	62	Atosik Lagoon, Chariot, Ikaknak Pond, Kisimilok Mountain, Kuropak Creek, Mad Hill
28	Kamynga, Ostrov Kardkarpko, Kovlyuneskin, Mys Vankarem, Vankarema, Laguna Vankarem	63	Akoviknak Lagoon, Cape Thompson, Crowbill Point, Igilerak Hill, Kemegrak Lagoon
29	Akanatkhyrgyn, Nutpel'men, Mys Onman, Vel'may	64	Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Kukpuk River, Pingu Bluff, Point Hope, Sinigrok Point, Sinuk
30	Laguna Kunergin, Nutepynmyn, Pyngopil'khin, Laguna Pyngopil'khin	65	Buckland, Cape Dyer, Cape Lewis, Cape Lisburne
31	Alyatki, Zaliv Tasytkhin, Kolyuchin Bay	66	Ayugatak Lagoon
32	Mys Dzhenretlen, Eynenekvyk, Lit'khekay-Polar Station	67	Cape Sabine, Pitmegea River
33	Neskan, Laguna Neskan, Mys Neskan	68	Agiak Lagoon, Pujuk Lagoon
34	Emelin, Ostrov Idlidlya, I, Memino, Tepken,	69	Cape Beaufort, Omalik Lagoon

ID	Geographic Place Names	ID	Geographic Place Names
35	Enurmino, Mys Keylu, Netakenishvin, Mys Neten,	70	Kuchaurak Creek, Kuchiak Creek
71	Kukpowruk River, Naokok, Naokok Pass, Sitkok Point	100	Foggy Island Bay, Kadleroshilik River, Lion Point, Shaviovik River, Tigvariak Island
72	Epizetka River, Kokolik River, Point Lay, Siksripak Point	101	Bullen Point, Point Gordon, Reliance Point
73	Akunik Pass, Tungaich Point, Tungak Creek	102	Flaxman Island, Maguire Islands, North Star Island, Point Hopson, Point Sweeney, Point Thomson, Staines River
74	Kasegaluk Lagoon, , Solivik Island, Utukok River	103	Brownlow Point, Canning River, Tamayariak River
75	Akeonik, Icy Cape, Icy Cape Pass	104	Camden Bay, Collinson Point, Katakturuk River, Konganevik Point, Simpson Cove
76	Akoliakatat Pass, Avak Inlet, Tunalik River	105	Anderson Point, Carter Creek, Itkilyariak Creek, Kajutakrok Creek, Marsh Creek, Sadlerochit River
77	Mitliktavik, Nivat Point, Nokotlek Point, Ongorakvik River	106	Arey Island, Arey Lagoon, Barter Island, Hulahula River, Okpilak River
78	Kilmantavi, Kuk River, Point Collie, Sigeakruk Point,	107	Bernard Harbor, Jago Lagoon, Kaktovik, Kaktovik Lagoon
79	Point Belcher, Wainwright, Wainwright Inlet	108	Griffin Point, Oruktalik Lagoon, Pokok Lagoon
80	Eluksingiak Point, Igklo River, Kugrua Bay	109	Angun Lagoon, Beaufort Lagoon, Nuvagapak Lagoon,
81	Peard Bay, Point Franklin, Seahorse Islands, Tachinisok Inlet	110	Aichilik River, Egaksrak Lagoon, Egaksrak River, Icy Reef, Kongakut River, Siku Lagoon
82	Skull Cliff	101	Demarcation Bay, Demarcation Point, Gordon, Pingokraluk Lagoon
83	Nulavik, Loran Radio Station	112	Clarence Lagoon, Backhouse River
84	Walakpa River, Will Rogers and Wiley Post Memorial	113	Komakuk Beach, Fish Creek
85	Barrow, Browerville, Elson Lagoon	114	Nunaluk Spit
86	Dease Inlet, Plover Islands, Sanigaruak Island	115	Herschel Island
87	Igalik Island, Kulgurak Island, Kurgorak Bay, Tangent Point	116	Ptarmagin Bay
88	Cape Simpson, Piasuk River, Sinclair River, Tulimanik Island	117	Roland & Phillips Bay, Kay Point
89	Ikpikpuk River, Point Poleakoon, Smith Bay	118	Sabine Point
90	Drew Point, Kolovik, McLeod Point,	119	Shingle Point
91	Lonely AFS Airport, Pitt Point, Pogik Bay, Smith River	120	Trent and Shoalwater Bays
92	Cape Halkett, Esook Trading Post, Garry Creek	121	Shallow Bay, West Channel
93	Atigaru Point, Eskimo Islands, Harrison Bay, Kalikpik River, Saktuina Point	120	Trent and Shoalwater Bays
94	Fish Creek, Tingmeachsiovik River	121	Shallow Bay, West Channel
95	Anachlik Island, Colville River, Colville River Delta	122	
96	Kalubik Creek, Oliktok Point, Thetis Mound,	123	Outer Shallow Bay, Olivier Islands
97	Beechey Point, Bertoncini, Bodfish, Cottle and, Jones Islands, Milne Point, Simpson Lagoon	124	Middle Channel, Gary Island
98	Gwydyr Bay, Kuparuk River, Long Island	125	Kendall Island
99	Duck Island, Foggy Island, Gull Island, Heald Point, Howe Island, Niakuk Islands, Point Brower	126	North Point, Pullen Island

Key: ID = identification (number).

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 21 Seasonal Land Segment ID, Vulnerable Period, and the General Resource.

SLS ID	Vulnerable	General Resource	SLS ID	Vulnerable	General Resource
25	May - October	Anadramous Fish	72	June - October	Anadramous Fish
28	July-November	Walrus	74	June - October	Anadramous Fish

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SLS ID	Vulnerable	General Resource	SLS ID	Vulnerable	General Resource
29	July-November	Walrus	80	June - October	Anadramous Fish
31	May - October	Anadramous Fish	85	August-November	Polar Bears
37	May - October	Anadramous Fish	87	June - October	Anadramous Fish
38	July-November	Walrus	89	June - October	Anadramous Fish
38	May - October	Anadramous Fish	91	June - October	Anadramous Fish
39	July- November	Anadramous Fish	93	June - October	Anadramous Fish
39	May - October	Anadramous Fish	94	June - October	Anadramous Fish
40	May - October	Anadramous Fish	95	June - October	Anadramous Fish
41	May - October	Anadramous Fish	96	June - October	Anadramous Fish
42	May - October	Anadramous Fish	97	June - October	Anadramous Fish
43	May - October	Anadramous Fish	98	June - October	Anadramous Fish
44	May - October	Anadramous Fish	99	June - October	Anadramous Fish
47	May - October	Anadramous Fish	100	June - October	Anadramous Fish
48	July-October	Spotted Seal	101	June - October	Anadramous Fish
49	May - October	Anadramous Fish	102	June - October	Anadramous Fish
51	May - October	Anadramous Fish	103	June - October	Anadramous Fish
53	May - October	Anadramous Fish	104	June - October	Anadramous Fish
54	May - October	Anadramous Fish	105	June - October	Anadramous Fish
55	May - October	Anadramous Fish	106	June - October	Anadramous Fish
56	May - October	Anadramous Fish	107	June - October	Anadramous Fish
57	May - October	Anadramous Fish	108	June - October	Anadramous Fish
58	May - October	Anadramous Fish	109	June - October	Anadramous Fish
59	May - October	Anadramous Fish	110	June - October	Anadramous Fish
60	May - October	Anadramous Fish	112	June - October	Anadramous Fish
64	May - October	Anadramous Fish	113	June - October	Anadramous Fish
67	May - October	Anadramous Fish	114	June - October	Anadramous Fish
70	May - October	Anadramous Fish	116	June - October	Anadramous Fish
71	May - October	Anadramous Fish	117	June - October	Anadramous Fish
72	June - October	Anadramous Fish	119	June - October	Anadramous Fish

Key: SLS = Seasonal Land Segment, ID=Identification (number)

Source: USDOI, MMS Alaska OCS Region (2008)

Table A.1- 22 Grouped Land Segment ID, Geographic Names of Grouped the Land Segment and Land Segments ID's which make up the Grouped Land Segment.

Grouped Land Segment ID	Grouped Land Segment Name	Land Segment ID's
127	Mys Blossom	1, 12
128	Bukhta Somnitel'naya	10, 11

Grouped Land Segment ID	Grouped Land Segment Name	Land Segment ID's
129	Ostrov Idlidlya	33,34
130	Mys Serditse Kamen	35, 36
131	Bering Land Bridge National Preserve	41, 42, 45-50
132	Cape Krusenstern National Monument	57-59
133	Alaska Maritime National Wildlife Refuge	62, 63, 65
134	Cape Lisburne	65, 66, 67
135	National Petroleum Reserve Alaska	76, 77, 80-83, 86-93
136	Kasegaluk Lagoon Special Area (NPR-A)	76-77
137	Teshekpuk Lake Special Area (NPR-A)	89-93
138	Arctic National Wildlife Refuge	103-111
139	Ivvavik National Park (Canada)	112-117
140	Kendall Island Bird Sanctuary (Canada)	124-125
141	Russia Chukchi Coast	1-39
142	Russia Chukchi Coast Marine Mammals	1-39
143	United States Chukchi Coast	40-84
144	United States Beaufort Coast	85-111
145	Canada Beaufort Coast	112-126

Source: USDO, MMS, Alaska OCS Region (2008).

Table A.1- 23 Beaufort Sea: Assumptions about How Launch Areas are Serviced by Pipelines for the Oil-Spill-Trajectory Analysis.

Launch Area(s)	Serviced by Hypothetical Pipelines	Launch Area(s)	Serviced by Hypothetical Pipelines
LA01 & LA02	PL1 to PL8	LA11	PL5 to PL11
LA03	PL2 to PL8	LA12	PL12
LA04	PL8	LA13	PL5 to PL12
LA05 & LA06	PL2 to PL9	LA14	PL6 to PL12
LA07	PL3 to PL10	LA15	PL13
LA08	PL9	LA16, LA17, LA18 & LA19	PL7 to PL13
LA09	PL4 to PL10	LA20	PL14, PL13, PL7
LA10	PL10		

Source: USDO, MMS, Alaska OCS Region (2008).

Table A.1- 24 Chukchi Sea: Assumptions about How Launch Areas are Serviced by Pipelines for the Oil-Spill-Trajectory Analysis.

Launch Area(s)	Serviced by Hypothetical Pipelines	Launch Area(s)	Serviced by Hypothetical Pipelines
LA01	PL02, PL03, PL04, PL05, PL06	LA08	PL10, PL11
LA02	PL04, PL05, PL06	LA09	PL01
LA03	PL07, PL08, PL09	LA10	PL03

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Launch Area(s)	Serviced by Hypothetical Pipelines	Launch Area(s)	Serviced by Hypothetical Pipelines
LA04	PL02, PL03	LA11	PL06
LA05	PL05, PL06	LA12	PL09
LA06	PL08, PL09	LA13	PL11
LA07	PL10, PL11		

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 25 Beaufort Sea: Estimated Mean Number of Large Platform, Pipeline and Total Spills Over the 20 Year Production Life.

Beaufort Sea	Name	3 Fields 20 Years Production		
		Mean Number of Platform/ Well Spills	Mean Number of Pipeline Spills	Mean Number of Spills Total
Beaufort Sea	Proposed Action	0.15	0.15	0.30

Note: Total equals the sum of mean platform/wells and pipeline spills over the 20 year production life

Source: USDOI, MMS, Alaska OCS Region (2008)

Table A.1- 26 Beaufort Sales: Estimated Chance of One or More Large Platform, Pipeline and Total Over the 20-Year Production Life.

Beaufort Sea	Name	3 Fields 20 Years Production		
		Percent Chance of One or More Platform/ Well Spills	Percent Chance of One or More Pipeline Spills	Percent Chance of One or More Spills Total
Beaufort Sea	Proposed Action	14	14	26

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 27 Chukchi Sea: Estimated Mean Number of Large Platform, Pipeline and Total s Over the 25-Year Production Life.

Chukchi Sea	Name	1 Field 25 Years Production		
		Mean Number of Platform/ Well Spills	Mean Number of Pipeline Spills	Mean Number of Spills Total
Chukchi Sea	Proposed Action	0.21	0.30	0.51

Source: USDOI, MMS, Alaska OCS Region (2008)

Table A.1- 28 Chukchi Sea: Estimated Chance of One or More Large Platform, Pipeline and Total Spills Over the 25-Year Production Life.

Chukchi Sea	Name	1 Field	25 Years	Production
		Percent Chance of One or More Platform/ Well Spills	Percent Chance of One or More Pipeline Spills	Percent Chance of One or More Spills Total
Chukchi Sea	Proposed Action	19	26	40

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 29 Small Crude-Oil Spills: Estimated Spill Rates for the Alaska North Slope.

Small Crude-Oil Spills <500 barrels, 1989-2000		
Total Volume of Spills	135,127 gallons	Note: Oil-spill databases are from the ADEC, Anchorage, Juneau, and Fairbanks. Alaska North Slope production data are derived from the TAPS throughput data from Alyeska Pipeline. Source: USDOI, MMS, Alaska OCS Region (2003).
	3,217 barrels	
Total Number of Spills	1,178 spills	
Average Spill Size	2.7 barrels	
Production (Crude Oil)	6.6 billion barrels	
Spill Rate	178 spills/billion barrels of crude oil produced	
Small Crude-Oil Spills ≥ 500 barrels and <1,000, 1985-2000		
Total Volume of Spills	171,150 gallons	Note: Oil-spill databases are from the ADEC, Anchorage, Juneau, and Fairbanks. BP Alaska Inc. and Arco. Alaska North Slope production data are derived from the TAPS throughput data from Alyeska Pipeline. Source: USDOI, MMS, Alaska OCS Region (2003).
	4,075 barrels	
Total Number of Spills	6	
Average Spill Size	680 barrels	
Production (Crude Oil)	9.36 billion barrels	
Spill Rate	0.64 spills/billion barrels of crude oil produced	

Table A.1- 30 Small Crude-Oil Spills: Assumed Spills over the Production Life of the Beaufort Sea.

Beaufort Sea	Assumed Small Crude-Oil Spills <500 barrels				
	Resources (Bbbl) ¹	Spill Rate (Spills/Bbbl)	Assumed Spill Size (bbl)	Estimated Number of Spills	Estimated Total Spill Volume (bbl)
Proposed Action	0.5	178	3	89	267
Beaufort Sea	Assumed Small Crude-Oil Spills ≥ 500 and ≤1,000 barrels				
	Resources (Bbbl) ¹	Spill Rate (Spills/Bbbl)	Assumed Spill Size (bbl)	Estimated Number of Spills	Estimated Total Spill Volume (bbl)
Proposed Action	0.5	0.64	680	0.32	0

Note: ¹The estimation of oil spills is based on the estimated resources produced. If these resources are not produced then no oil spills occur.

Source: USDOI, MMS, Alaska OCS Region (2008).

Table A.1- 31 Small Crude-Oil Spills: Assumed Size Distribution over the 20-Year Production Life of the Beaufort Sea.

Size ²	Distribution % in ADEC database	Proposed Action
<1 gallon	19.14	17
>1 and ≤5 gallons	35.37	32
>5 gallons and <1 bbl	20.41	18
Total <1 bbl		67
≥1 bbl and ≤5 bbl	20.61	18
>5 and ≤25 bbl	3.92	3
> 25 and <500 bbl	1.4	1
≥500 and ≤1,000 bbl	--	0
Total >1 and ≤1,000 bbl		22
Total Volume (bbl)		267

Notes: ¹Estimated number of spills is rounded to the nearest whole number.

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²Spill-size distributions are allocated by multiplying the total estimated number of spills by the fraction of spills in that size category from the Alaska Department of Environmental Conservation (ADEC) database.

Source: USDOl, MMS, Alaska OCS Region (2006) and USDOl, MMS Alaska OCS Region (2008).

Table A.1- 32 Small Crude-Oil Spills: Assumed Spills over the 25-Year Production Life of the Chukchi Sea.

Chukchi Sea	Assumed Small Crude-Oil Spills <500 barrels				
	Resources (Bbbl) ¹	Spill Rate (Spills/Bbbl)	Assumed Spill Size (bbl)	Estimated Number of Spills	Estimated Total Spill Volume (bbl)
Proposed Action	1	178	3	178	534
Chukchi Sea	Assumed Small Crude-Oil Spills ≥ 500 and ≤1,000 barrels				
	Resources (Bbbl) ¹	Spill Rate (Spills/Bbbl)	Assumed Spill Size (bbl)	Estimated Number of Spills	Estimated Total Spill Volume (bbl)
Proposed Action	1	0.64	680	0.64	680

Note: ¹The estimation of oil spills is based on the estimated resources produced. If these resources are not produced then no oil spills occur.

Source: USDOl, MMS, Alaska OCS Region (2008).

Table A.1- 33 Small Crude-Oil Spills: Assumed Size Distribution over the Production Life of the Chukchi Sea.

Size ²	Distribution % in ADEC database	Proposed Action
<1 gallon	19.14	34
>1 and ≤5 gallons	35.37	63
>5 gallons and <1 bbl	20.41	36
Total <1 bbl		133
≥1 bbl and ≤bbl 5	20.61	36
>5 and ≤25 bbl	3.92	7
> 25 and <500 bbl	1.4	2
≥500 and ≤1,000 bbl	--	1
Total >1 and ≤1,000 bbl		46
Total Volume (bbl)		1,214

Notes: ¹Estimated number of spills is rounded to the nearest whole number.

²Spill-size distributions are allocated by multiplying the total estimated number of spills by the fraction of spills in that size category from the Alaska Department of Environmental Conservation (ADEC) database.

Source: USDOl, MMS, Alaska OCS Region (2006, 2008).

Table A.1- 34 Small Refined-Oil Spills: Estimated Rate for the Alaska North Slope.

Estimated Small Refined Spill Rate for the Alaska North Slope, 1989-2000	
Total Volume of Spills	94,195 gallons
	2,243 barrels
Total Number of Spills	2,915 spills
Average Spill Size	0.7 barrels (29 gallons)
Production (Crude Oil)	6.6 billion barrels
Spill Rate	440 spills/billion barrels of crude oil produced

Source: USDOl, MMS, Alaska OCS Region (2003).

Table A.1- 35 Small Refined-Oil Spills: Assumed Spills over the Production Life of the Beaufort Sea.

Beaufort Sea	Resource Range (Bbbl)	Spill Rate (Spills/Bbbl)	Average Spill Size (bbl)	Estimated Number of Spills ¹	Estimated Total Spill Volume (bbl) ¹
Proposal	0.50	440	0.7 (29 gal)	220	154

Note: ¹The fractional estimated mean spill number and volume is rounded to the nearest whole number.

Key: Bbbl = Billion barrels. bbl = barrel. gal = gallon.

Source: USDOl, MMS, Alaska OCS Region (2008).

Table A.1- 36 Small Refined-Oil Spills: Assumed Spills over the Production Life of the Chukchi Sea.

Chukchi Sea	Resource Range (Bbbl)	Spill Rate (Spills/Bbbl)	Average Spill Size (bbl)	Estimated Number of Spills ¹	Estimated Total Spill Volume (bbl) ¹
Proposal	1	440	0.7 (29 gal)	440	308

Note: ¹The fractional estimated mean spill number and volume is rounded to the nearest whole number.

Key: Bbbl = Billion barrels. bbl = barrel. gal = gallon.

Source: USDOl, MMS, Alaska OCS Region (2008).

Table A.1- 37 Small Refined Oil Spill: Assumed Number and Volume of Spills over the Maximum Annual Level Of Exploration On The OCS Of The Chukchi Sea Or Beaufort Sea.

	Number of Activities	Estimated Number of Small Spills	Estimated Volume of Small Spills (bbl)
G&G operation	9	0 - 9	0 - <9
Exploration drilling	2	0 - 2	0 - ≤100

Note: The analysis upper range conservatively estimates every refueling operation could have a small fuel spill.

Table A.1- 38 Very Large Oil Spill Scenario: Source, Rate, Duration and Volume and timing estimates.

	Beaufort Sea	Chukchi Sea
NEPA Document	Beaufort Multi-sale 186, 195, 202 FEIS	Sale 193 Final SEIS
Source	Well Control Incident	Well Control Incident
Rate	15,000 barrels of oil per day	20,000-60,000 barrels of oil per day
Duration	15 days	39-74 days
Total Initial Volume	225,000 bbl	1.2-2.4 MMbbl
Initial Event	All Year	July 1-October 15
Location	Launch areas 10 and 12	All launch areas

Source: USDOl, 2003 Section IV.I and USDOl, BOEMRE, 2011b, Section IV.D.

Table A.1- 39 Comparison of Very Large Oil Spill Scenario Elements to Worst Case Discharge Information.

Description	Beaufort Multiple-sale EIS	Torpedo H (BOEMRE)	Torpedo H (Shell)	Relative Change (BOEMRE)
Flow Rate	15,000 bopd	2,498 bopd	9,468 bopd ¹	Two-thirds the daily flow
Length of Flow	15 days	15 days	15 days	Same
Volume	225,000 barrels ²	37,470 barrels	142, 020 barrels	Two-thirds the volume
Oil Type	38 °API	35 °API	35 °API	Similar oil quality
Location	Surface	Surface or Subsurface (subsurface modeled for WCD)	Surface or Subsurface (subsurface modeled for WCD)	Subsurface likely will surface within 1000 m of the location of loss of well control
Mitigation	Cleanup	Potential for oil to be collected within 15 days with the capping and containment system prior to reaching the sea surface and spreading		

Source: Shell Offshore Inc. (2011) and BOEMRE (2011c).

Key: °API = American Petroleum Institute gravity (API), Bopd = barrels of oil per day

¹Provided as required by 30 CFR 250.213 and 250.219

²Approximately 180,000 barrels estimated to reach the marine environment

Table A.1- 40 Historical Very Large Oil Spills from Offshore Well Control Incidents 1965-2010..

Name	Company	Spill Source	Activity	Location	Oil	Begin	End	Duration (Days)	Bbls	Source
Deep Water Horizon/ Macondo MC 252	BP	Expl. Well	Temporary Abandonment	U.S. OCS, Gulf of Mexico	Crude	4/20/ 2010	7/15/ 2010	87	4,900,000	McNutt et al. 2011. National Oil Spill Commission 2011.
Ixtoc	PEMEX	Expl. Well	Drilling	Mexico, Gulf of Mexico	Crude	6/3/ 1979	3/23/ 1980	295	3,500,000	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.
Dubai		Dev. Well	Drilling			1973			2,000,000	Gulf Canada Resources Inc
Nowruz Oil Field No. 3 Well*	Iranian Offshore Oil	Platform	Production	Iran, Persian Gulf	Crude	2/4/ 1983	9/18/ 1983	224	1,904,762	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.
Abkatun 91	PEMEX	Prod. Well	Workover	Mexico, Gulf of Mexico, Bay of Campeche		10/ 23/ 1986		15	247,000	OSIR, 1998; Etkin, 2009; Fingas, 2000;
Ekofisk Bravo Platform B14	Phillips Petroleum	Prod. Well	Workover	Norway, North Sea, Ekofisk Oil Field	Crude	04/22/ 1977	4/30/ 1977	8	202,381	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.
Funiwa No. 5 Well	Nigerian National Petroleum	Prod. Well	Drilling	Nigeria, Niger Delta/ Atlantic Ocean	Crude	01/17/ 1980	2/1/ 1980	14	200,000	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.

Note: * Military attack-related events; cells with no data means the information is not readily available in the open literature.

Source: USDO, BOEMRE, (2011) compiled from cited references

Table A.1- 41 Summer Conditional Probabilities (Expressed as Percent Chance) that a Large Spill Starting at Launch Areas 1-25 or Pipeline Segments 1-17 Will Contact Certain Important Fall Feeding and Denning Areas for Polar Bears in the Beaufort Sea Within 30 or 360 Days.

ERA ID	ERA Name	30 Days LAs 1-25	30 Days PLs 1-17	360 Days LAs 1-25	360 Days PLs 1-17
ERA 55	Pt. Barrow, Plover area	<0.5-38%	<0.5-29%	<0.5-40%	<0.5-32%
ERA 92	Thetis, Jones, Cottle, and Return Islands	<0.5-11%	<0.5-11%	<0.5-12%	<0.5-12%
ERA 93	Cross and No Name Islands	<0.5-6%	<0.5-7%	<0.5-7%	<0.5-7%
ERA 94	Maguire, Flaxman, and Barrier Islands	<0.5-6%	<0.5-9%	<0.5-7%	<0.5-10%
ERA 95	Arey and Barter, and Bernard Spit	<0.5-5%	<0.5-3%	<0.5-5%	<0.5-3%
GLS 138	Arctic National Wildlife Refuge	<0.5-54%	<0.5-45%	1-53%	1-49%
GLS 144	U.S. Beaufort Sea Coastline	<0.5-63%	1-59%	30-72%	36-69%

Source: USDOl, MMS (2008) Appendix A, Tables A.2-65, A.2-66, A.2-71 and A.2-72.

Table A.1- 42 Winter Conditional Probabilities (Expressed as Percent Chance) that a Large Spill Starting at Launch Areas 1-25 Or Pipeline Segments 1-17 Will Contact Certain Important Fall Feeding and Denning Areas for Polar Bears in the Beaufort Sea Within 30 or 360 Days.

ERA/GLS ID	ERA Name	30 Days LAs 1-25	30 Days PLs 1-17	360 Days LAs 1-25	360 Days PLs 1-17
55	Pt. Barrow, Plover area	<0.5-4%	<0.5-3%	<0.5-4%	<0.5-4%
92	Thetis, Jones, Cottle, and Return Islands	<0.5-3%	<0.5-3%	<0.5-14%	<0.5-11%
93	Cross and No Name Islands	<0.5-1%	<0.5-1%	<0.5-1%	<0.5-1%
94	Maguire, Flaxman, and Barrier Islands	<0.5-2%	<0.5-3%	<0.5-9%	<0.5-10%
95	Arey, Barter, and Bernard Spit	<0.5%	<0.5%	<0.5-1%	<0.5-1%
GLS 138	Arctic National Wildlife Refuge	<0.5-14%	<0.5-12%	1-49%	1-45%
GLS 144	U.S. Beaufort Sea Coastline	20-55%	26-55%	30-72%	26-55%

Source: USDOl, MMS (2008) Appendix A, Tables A.2-65, A.2-66, A.2-71 and A.2-72.

Table A.1- 43 Summer Conditional Probabilities (Expressed as Percent Chance) that a Large Spill Starting at Launch Areas 1-15 or Pipeline Segments 1-11 Will Contact Certain Important Fall Feeding and Denning Areas for Polar Bears in the Chukchi Sea Within 30 or 360 Days.

ERA ID	ERA Name	30 Days LAs 1-15	30 Days PLs 1-11	360 Days LAs 1-15	360 Days PLs 1-11
ERA 11	Wrangel Island with 12 NM Buffer	<0.5-2	<0.5-2	<0.5-2	<0.5-2
ERA 19	Chukchi Sea spring lead System	<0.5-9	<0.5-14	<0.5-10	<0.5-14
ERA 39	Pt. Lay/ Chukchi Sea polynya area	<0.5-16	<0.5-41	<0.5-19	<0.5-44
ERA 40	Wainwright/ Chukchi Sea polynya area	<0.5-19	<0.5-51	<0.5-26	<0.5-57
ERA 55	Pt. Barrow, Plover Islands	<0.5-3	<0.5-1	<0.5-7	<0.5-3
ERA 58	Chukchi Sea polynya area offshore	1-84	4-82	2-85	6-82
ERA 59	Ostrov Kolyuchin	<0.5-2	<0.5-2	<0.5-2	<0.5-2
ERA 66	Herald island	<0.5-1	<0.5-1	<0.5-1	<0.5-1
LS 85	Barrow, Browerville, Elson Lagoon	<0.5-8	<0.5-4	<0.5-13	<0.5-8

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ERA ID	ERA Name	30 Days LAs 1-15	30 Days PLs 1-11	360 Days LAs 1-15	360 Days PLs 1-11
GLS 142 ¹	Russian Chukchi Sea coastline	<0.5-20	<0.5-20	1-20	<0.5-20
GLS 143 ¹	U. S. Chukchi Sea coastline	<0.5-22	<0.5-35	1-31	3-43
GLS 144 ¹	U. S. Beaufort Sea coastline	<0.5-10	<0.5-5	<0.5-23	<0.5-13

Note: ¹Most contacts to GLS 143 occur to LSs 64-85 (Pt. Hope to Barrow). We use GLS 142, 143 and 144 as a proxy to represent potentially available coastal denning habitat.

Source: Appendix A, Tables A.3-33, A.3-36, A.3-39, A.3-42, A.3-45 and A.3-48.

Table A.1- 44 Winter Conditional Probabilities (Expressed as Percent Chance) that a Large Spill Starting at Launch Areas 1-15 or Pipeline Segments 1-11 Will Contact Certain Important Fall Feeding and Denning Areas for Polar Bears in the Chukchi Sea Within 30 or 360 Days.

ERA ID	ERA Name	30 Days LAs 1-15	30 Days PLs 1-11	360 Days LAs 1-15	360 Days PLs 1-11
ERA 11	Wrangel Island with 12 NM Buffer	<0.5	<0.5	<0.5	<0.5
ERA 19	Chukchi Sea spring lead System	<0.5-16	<0.5-23	<0.5-26	<0.5-35
ERA 39	Pt. Lay/ Chukchi Sea polynya area	<0.5-16	<0.5-32	<0.5-25	<0.5-39
ERA 40	Wainwright/ Chukchi Sea polynya area	<0.5-8	<0.5-38	<0.5-18	<0.5-52
ERA 55	Pt. Barrow, Plover Islands	<0.5	<0.5	<0.5-3	<0.5-3
ERA 58	Chukchi Sea polynya area offshore	<0.5-18	<0.5-19	2-33	2-37
ERA 59	Ostrov Kolyuchin	<0.5	<0.5	<0.5	<0.5
ERA 66	Herald island	<0.5	<0.5	<0.5-1	<0.5-1
LS 85	Barrow, Browerville, Elson Lagoon	<0.5-2	<0.5-1	<0.5-6	<0.5-6
GLS 142 ¹	Russian Chukchi Sea coastline	<0.5-8	<0.5-8	<0.5-8	<0.5-9
GLS 143 ¹	U. S. Chukchi Sea coastline	<0.5-13	<0.5-21	<0.5-28	2-38
GLS 144 ¹	U. S. Beaufort Sea coastline	<0.5	<0.5-1	<0.5-11	<0.5-10

Note: ¹Most contacts to GLS 143 occur to LSs 64-85 (Pt. Hope to Barrow). We use GLS 142, 143 and 144 as a proxy to represent potentially available coastal denning habitat.

Source: Appendix A, Tables A.3-33, A.3-36, A.3-39, A.3-42, A.3-45 and A.3-48.

Table A.1- 45 Combined Probabilities (Expressed as Percent Chance) of One or More Spills Greater Than or Equal to 1,000 Barrels Originating in the Beaufort Sea Occurring and Contacting the Two Most Important Environmental Resource Areas for ESA-Listed Birds (See Maps in Appendix A) Over the Assumed Production Life of the Sale Area Within Varying Time Periods, Beaufort Sea Sales 209, 217.

Environmental Resource Area	3 Days	10 Days	30 Days	60 Days	180 Days	360 Days
ERA 10 Ledyard Bay Critical Habitat Unit	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
ERA 19 Spring Lead system	<0.5	<0.5	<0.5	<0.5	<0.5	1

Source: USDOl, MMS (2008) Appendix A, Table A2-157

Table A.1- 46 Combined Probabilities (expressed as percent Chance) of One or More Spills Greater than or Equal to 1,000 Barrels Originating in the Chukchi Sea Occurring and Contacting the Two Most Important Environmental Resource Areas for ESA-Listed Birds (see maps, Appendix A) over the Assumed Production Life of the Lease-Sale Area with Varying Time Periods, Chukchi Sea.

Environmental Resource Area	3 Days	10 Days	30 Days	60 Days	180 Days	360 Days
ERA 10 Ledyard Bay Critical Habitat Unit	3	4	5	6	6	6
ERA 19 Spring Lead System	2	3	5	6	7	7

Source: USDOl, MMS (2008) Appendix A, Table A3-79

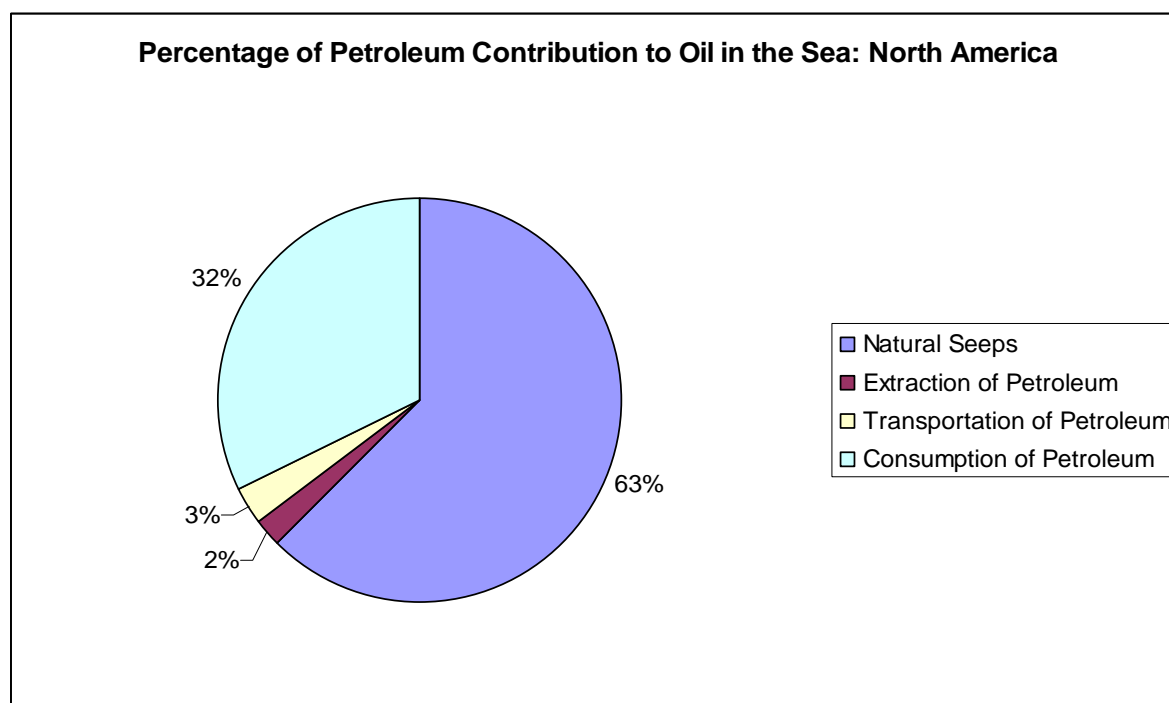
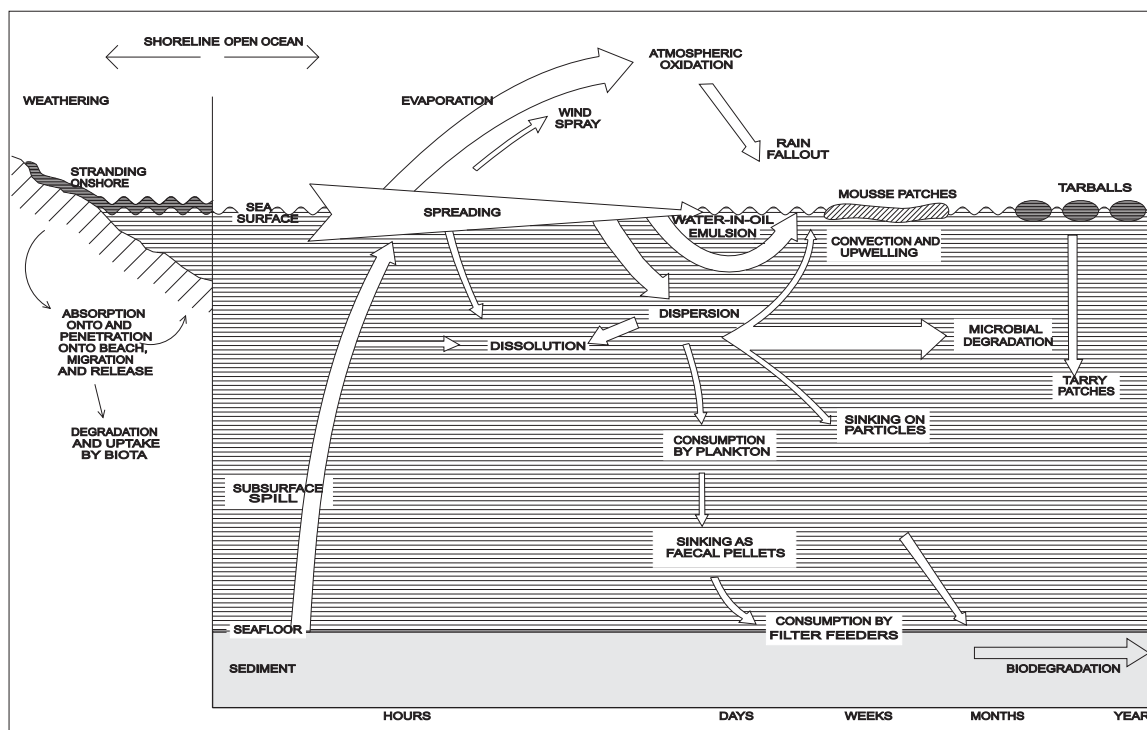
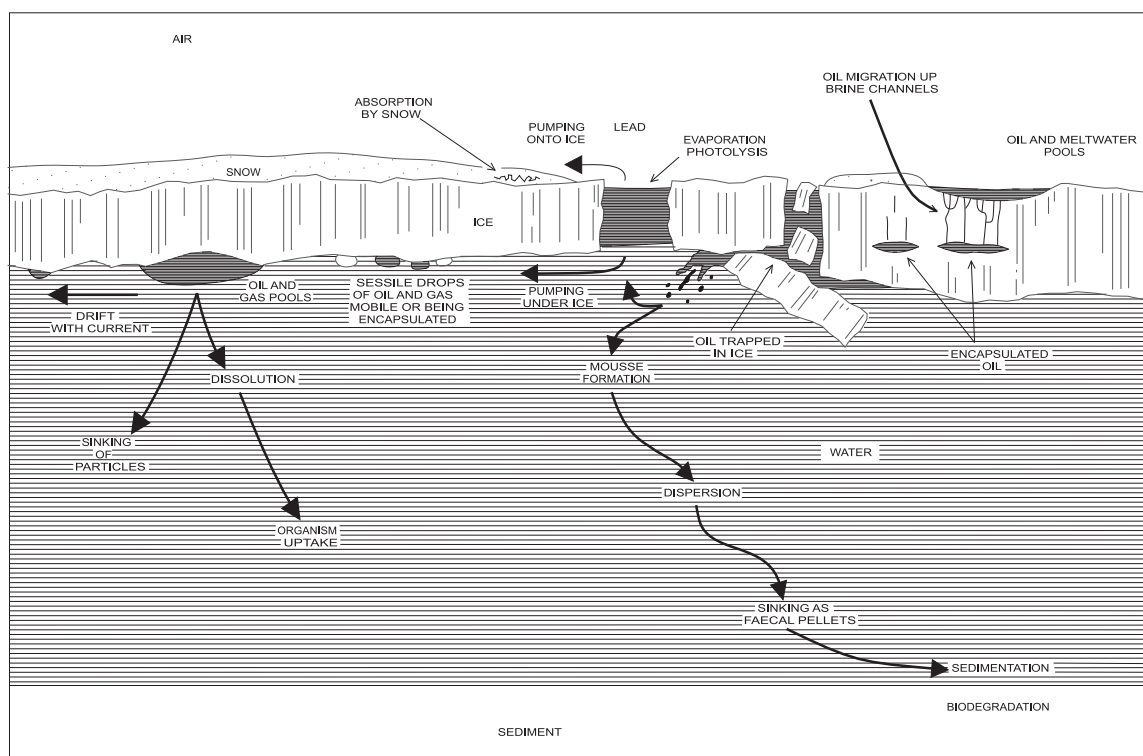


Figure A.1- 1 Contributions of Oil in the Sea for North America (National Research Council, 2003).



Source: After MacKay, 1985, and Rasmussen, (1985).



Source: After Hillman and Shafer (1983), and Mackay, (1985).

Figure A.1- 2 Fate of Oil Spills in the Ocean During the Arctic Summer and Winter.

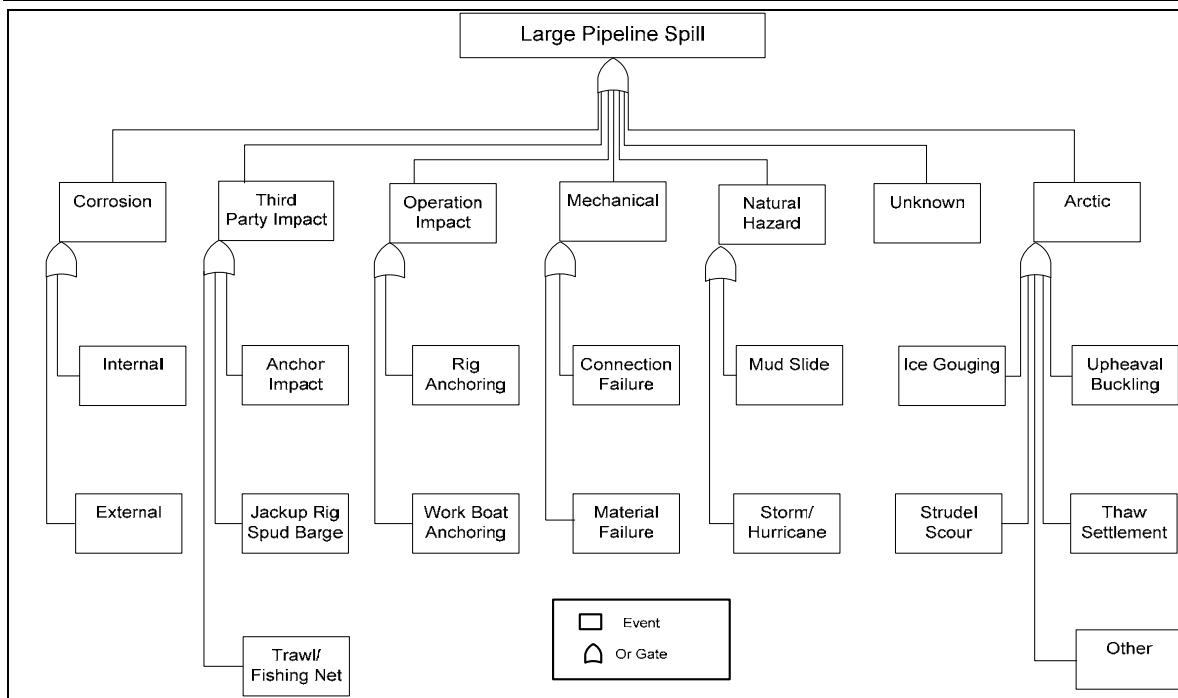


Figure A.1- 3 Typical Fault Tree for a Pipeline Spill.

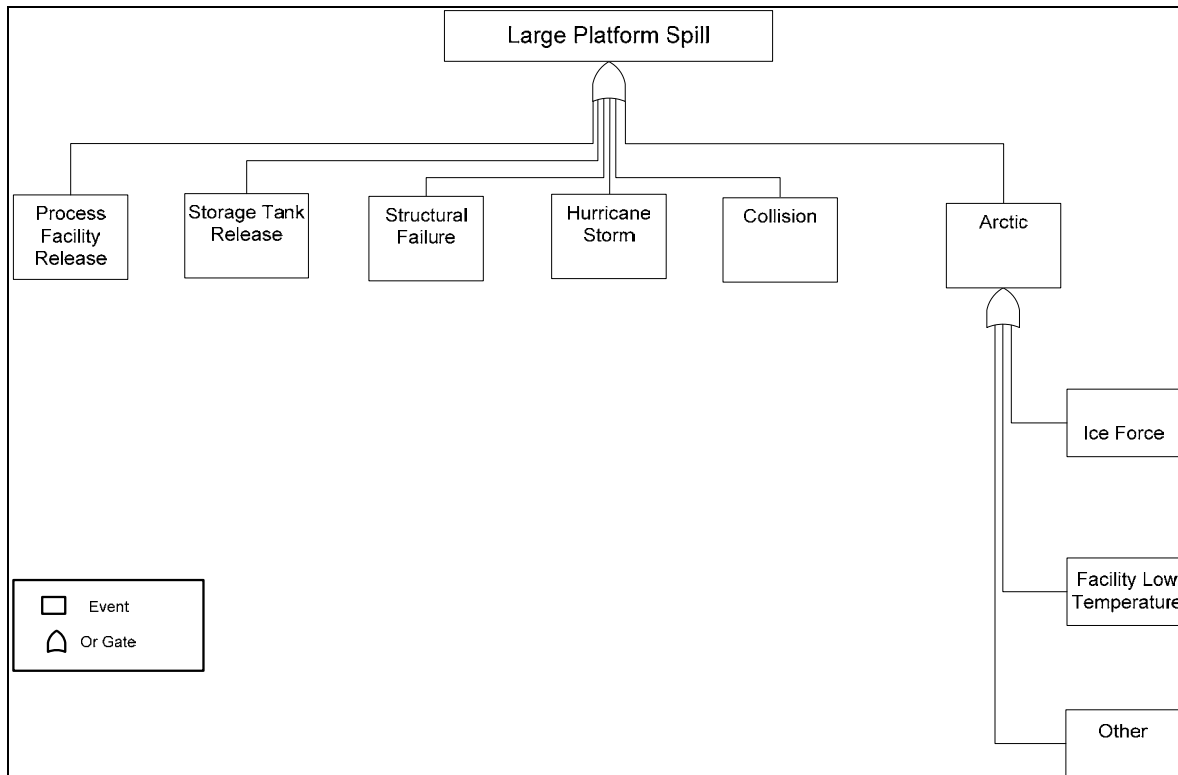


Figure A.1- 4 Typical Fault Tree for a Platform Spill.

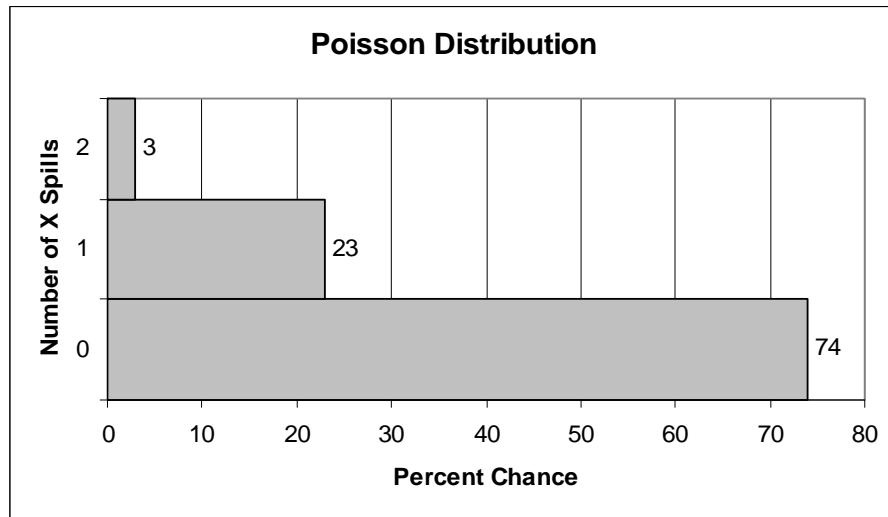


Figure A.1- 5 Poisson Distribution: Beaufort Sea, Proposed Action, Total (Pipeline and Platform) over the 20-Year Production Life.

Mean Number of Spills	0.3
Percent Chance of One or More	26%
Percent Chance of No Spills	74%
Most Likely Number	0

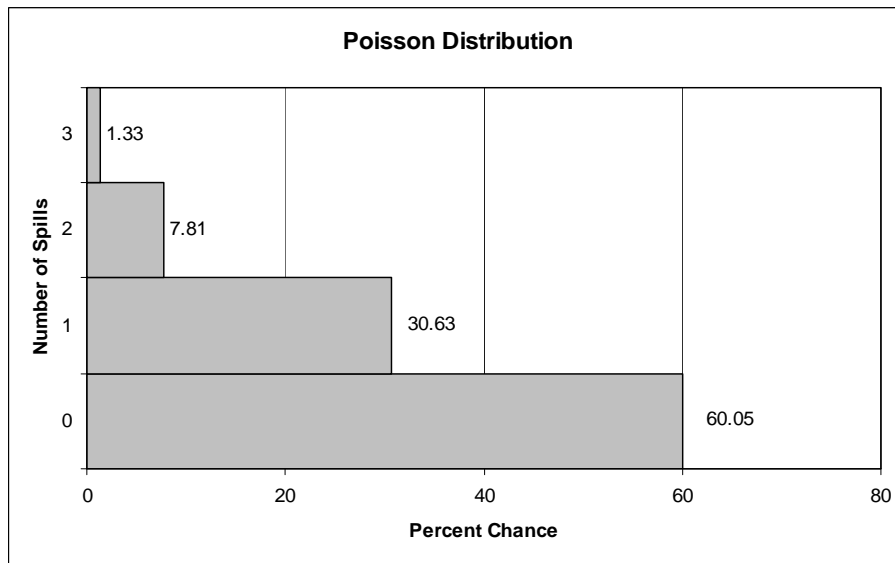


Figure A.1- 6 Poisson Distribution: Chukchi Sea, Proposed Action, Total (Pipeline and Platform) over the 25-Year Production Life.

Mean Number of Spills	0.51
Percent Chance of One or More	40%
Percent Chance of No Spills	60%
Most Likely Number	0

APPENDIX B
EPA CONSULTATION MATERIALS

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Appendix B

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B. EPA CONSULTATION

The enclosed documents include two cover letters and an analysis sent by Region 10 of the Environmental Protection Agency to the U.S. Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration Fisheries Service (NMFS) (collectively "the Services") concerning the potential effects of EPA's draft Clean Air Act (CAA) permit for ConocoPhillips (COP) on Endangered Species Act (ESA) listed and proposed species and their designated critical habitat.

BOEMRE continues as the lead agency for exploratory oil and gas operations in the Arctic and EPA relies on its consultations. FWS and NMFS have indicated that this approach is still acceptable. FWS suggested that EPA copy BOEMRE on their correspondence and accompanying analysis with the Services regarding the exploration activities in the Arctic and that EPA has requested that BOEMRE include their (EPA's) analyses and information about CAA permits in its consultations with the Services. The enclosed documents serve as a model for further EPA consultations on specific Arctic Region CAA impacting activities.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR, WASTE AND TOXICS

JUL 25 2011

Mr. Fred King
Acting Regional Supervisor
Office of Leasing and Environment
Alaska Outer Continental Shelf Region
Bureau of Ocean Energy Management
Regulation and Enforcement
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503

Dear Mr. King:

This letter transmits two cover letters and an analysis sent by Region 10 of the Environmental Protection Agency to the U.S. Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration Fisheries Service (NMFS) (collectively "the Services") concerning the potential effects of EPA's draft Clean Air Act (CAA) permit for ConocoPhillips (COP) on Endangered Species Act (ESA) listed and proposed species and their designated critical habitat.

On July 22, 2011, EPA proposed and requested public comment on a draft CAA permit for COP to operate a jack-up drill rig to conduct exploratory drilling on the Outer Continental Shelf in the Chukchi Sea in its Lease Sale 193 lease blocks. Public comment on this permit closes on September 6, 2011.

In previous discussions between FWS and several federal agencies, including EPA and BOEMRE, it was acknowledged that BOEMRE will continue as the lead agency for exploratory oil and gas operations in the Arctic and that EPA may continue to rely on its consultations. FWS specifically indicated that this approach is still acceptable. FWS also suggested that we copy BOEMRE on our correspondence and accompanying analysis with the Services regarding the exploration activities in the Arctic and that we ask BOEMRE to include our analysis and information about the CAA permits in its consultations with the Services. We understand that BOEMRE is in the process of completing a Revised Environmental Impact Statement for the Chukchi Sea Planning Area Lease Sale 193 and is updating its consultation to reflect recent ESA-related regulatory changes. Accordingly, we request that you include our enclosed analysis and information about the CAA permits in your consultations with the Services. If you need any additional information please call me at 206-553-1582 or Madonna Narvaez at 206-553-2117.

Sincerely,

Janis Hastings, Deputy Director
Office of Air, Waste and Toxics

The signature of Janis Hastings is written in black ink above her name. The signature is a cursive-style name that appears to read "Janis Hastings".

Enclosures

1. Letter to Mr. Ted Swem and Ms. Rosa Meehan, U.S. Fish and Wildlife Service
2. Letter to Ms. Kaja Brix, National Marine Fisheries Service
3. Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA) Section 7 and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Section 305(b)(2) Determinations for the ConocoPhillips Outer Continental Shelf Title V Air Permit – Chukchi Sea

cc:

James Lima
Chief, Environmental Analysis Section,
BOEMRE, Anchorage

Mark Schroeder
BOEMRE, Anchorage



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR, WASTE AND TOXICS

JUL 25 2011

Mr. Ted Swem
Endangered Species Branch Chief
US Fish and Wildlife Service
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

Ms. Rosa Meehan, Supervisor
US Fish and Wildlife Service
Marine Mammals Management
1011 East Tudor Road, MS 341
Anchorage, Alaska 99503

Dear Mr. Swem and Ms. Meehan:

With this letter, Region 10 of the Environmental Protection Agency transmits its evaluation of the potential effects of air permits issued under the Clean Air Act (CAA) on proposed and listed species, and requests your concurrence with its conclusions. This letter is part of EPA's informal discussions with your staff regarding a CAA permit that we are proposing to issue to ConocoPhillips (COP) for exploratory drilling on the Outer Continental Shelf (OCS) in the Chukchi Sea.

In February 2010, COP submitted an application for an OCS/minor source CAA permit to construct and operate a jack-up drill rig (Rig) to conduct exploratory drilling operations on specified lease blocks in the Chukchi Sea. COP proposes to conduct exploratory drilling over a period of approximately 100 days during a drilling season that will be limited to July 1 through November 30. EPA proposed the draft OCS/minor source permit for COP's Chukchi Sea operations and requested public comment on July 22, 2011. The public comment period closes on September 6, 2011.

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is the lead agency consulting with FWS on oil and gas exploratory drilling operations in the Chukchi Sea. In addition to the completed and ongoing consultations between BOEMRE and FWS, EPA has previously held informal discussions with your staff concerning CAA permits for Shell Offshore, Inc. and Shell Gulf of Mexico, Inc. to conduct exploratory drilling in the Beaufort and Chukchi Sea OCS. EPA appreciates your cooperation and timely responses with respect to the Shell CAA permits, and proposes a similar process for COP's CAA permit to conduct exploratory drilling in the Chukchi Sea OCS.

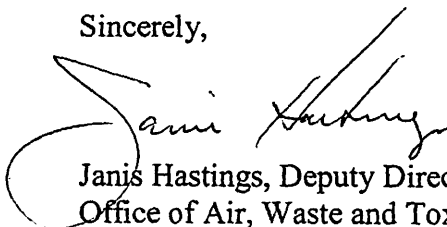
Since the last programmatic Biological Opinion for oil and gas exploratory activities in the Chukchi Sea issued by FWS in September 2009, there have been a number of ESA-related regulatory changes. These changes include the designation of polar bear critical habitat and the

addition of Pacific walruses to the list of candidate species. The evaluation enclosed with this letter analyzes factors specific to the CAA permit, including specific air emission information, as these factors relate to the recent ESA-related regulatory changes described above. The evaluation provides EPA's basis for concluding that air emissions from COP's exploratory drilling in the Chukchi Sea, as authorized and regulated by the draft CAA permit, would have no adverse effects on polar bear critical habitat or Pacific walruses.

EPA's evaluation is intended to supplement BOEMRE's ongoing consultations with FWS. We have requested that BOEMRE consider and include information contained in the enclosed analysis during its ongoing consultations. The draft CAA permit does not relieve COP from its obligation to comply with other applicable state and federal requirements, including requirements, as appropriate, to obtain annual letters of authorization or other applicable authorizations or approvals.

We are requesting that FWS concur in writing with our conclusions. We would appreciate your response by August 19, 2011, if possible. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or Madonna Narvaez at 206-553-2117.

Sincerely,



Janis Hastings, Deputy Director
Office of Air, Waste and Toxics

Enclosure

1. Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA) Section 7 and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Section 305(b)(2) Determinations for the ConocoPhillips Outer Continental Shelf Title V Air Permit – Chukchi Sea

cc: Shannon Torrence
USFWS, Field Office
Fairbanks

Craig Perham
USFWS, Marine Mammals Management
Anchorage

Mark Schroeder,
BOEMRE, Anchorage





UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR, WASTE AND TOXICS

JUL 25 2011

Ms. Kaja Brix
Assistant Regional Administrator
Protected Resources Division
National Marine Fisheries Service
Alaska Region
709 West 9th Street
P.O. Box 21668
Juneau, Alaska 99802-1668

Dear Ms. Brix:

With this letter, Region 10 of the Environmental Protection Agency transmits its evaluation of the potential effects of air permits issued under the Clean Air Act (CAA) on proposed and listed species, and requests your concurrence with its conclusions. This letter is part of EPA's informal discussions with your staff regarding a CAA permit that we are proposing to issue to ConocoPhillips (COP) for exploratory drilling on the Outer Continental Shelf (OCS) in the Chukchi Sea.

In February 2010, COP submitted an application for an OCS/minor source CAA permit to construct and operate a jack-up drill rig (Rig) to conduct exploratory drilling operations on specified lease blocks in the Chukchi Sea. COP proposes to conduct exploratory drilling over a period of approximately 100 days during a drilling season that will be limited to July 1 through November 30. EPA proposed the draft OCS/minor source permit for COP's Chukchi Sea operations and requested public comment on July 22, 2011. The public comment period closes on September 6, 2011.

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is the lead agency consulting with NMFS on oil and gas exploratory drilling operations in the Beaufort and Chukchi Seas. In addition to the completed and ongoing consultations between BOEMRE and NMFS, EPA has previously held informal discussions with your staff concerning CAA permits for Shell Offshore, Inc. and Shell Gulf of Mexico, Inc. to conduct exploratory drilling in the Beaufort and Chukchi Sea OCS. EPA appreciates your cooperation and timely responses with respect to the Shell CAA permits, and proposes a similar process for COP's CAA permit to conduct exploratory drilling in the Chukchi Sea OCS.

Since the last programmatic Biological Opinion for oil and gas exploratory activities in the Chukchi Sea issued by NMFS in July 2008, there have been a number of ESA-related regulatory changes. These changes include the proposal to list as threatened ringed seals and two subspecies of bearded seals, and the identification of possible impacts to the olfactory system of endangered bowhead whales. The evaluation enclosed with this letter analyzes factors specific to the CAA permit, including specific air emission information, as these factors relate to the recent ESA-related regulatory changes described above. The evaluation provides EPA's basis for concluding

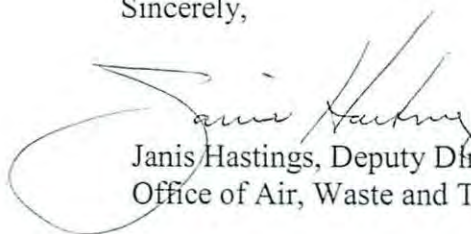
that air emissions from COP's exploratory drilling in the Chukchi Sea, as authorized and regulated by the draft CAA permit, would have no adverse effects on proposed bearded and ringed seals or the olfactory system of the bowhead whale.

BOEMRE completed and is conducting ongoing consultations with NMFS concerning the effects of COP's drilling operations on essential fish habitat. The enclosed evaluation also includes EPA's conclusion that the issuance of the air permits will have no effect on essential fish habitat.

EPA's evaluation is intended to supplement BOEMRE's ongoing consultations with NMFS. We have requested that BOEMRE consider and include information contained in the enclosed analysis during its ongoing consultations. The draft CAA permit does not relieve COP from its obligation to comply with other applicable state and federal requirements, including requirements, as appropriate, to obtain annual letters of authorization or other applicable authorizations or approvals.

We are requesting that NMFS concur in writing with our conclusions. We would appreciate your response by August 19, 2011, if possible. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or Madonna Narvaez at 206-553-2117.

Sincerely,



Janis Hastings, Deputy Director
Office of Air, Waste and Toxics

Enclosure

1. Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA) Section 7 and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Section 305(b)(2) Determinations for the ConocoPhillips Outer Continental Shelf Title V Air Permit – Chukchi Sea.

cc: Brad Smith,
NMFS, Anchorage

Mark Schroeder,
BOEMRE, Anchorage

Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA) Section 7 and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Section 305(b)(2) Determinations for the ConocoPhillips Outer Continental Shelf Title V Air Permit – Chukchi Sea

I. Background

ConocoPhillips Company (COP) proposes to conduct exploratory drilling on the Outer Continental Shelf (OCS) in the Devil's Paw prospect of Lease Sale 193 in the Chukchi Sea. The prospect's location is more than 25 miles from Alaska's seaward boundary and ranges from 60-92 miles (111-148 km) from the nearest point on the Alaska coast, 100-120 miles (185-222 km) from Wainwright, and 70-90 miles (129-166 km) from Point Lay. Pursuant to Section 328 of the Clean Air Act (CAA), 42 U.S.C. § 7627, EPA promulgated regulations at 40 C.F.R. Part 55 that are applicable to OCS sources of air pollution. COP applied for a Title V air permit to operate an OCS source and associated fleet for purposes of conducting exploratory drilling. To ensure that it remained a minor source of air pollution, COP requested that its permit contain certain federally enforceable limits on its emissions and operations.

The draft Title V permit would authorize COP to operate a Jackup Drill Rig (Rig) during a drilling season limited to July 1 through November 30. COP intends to conduct an initial exploratory drilling season in the summer/fall of 2013. Exploratory drilling will continue in subsequent seasons only if a significant accumulation of hydrocarbons is discovered. At that point, COP may drill one to three additional appraisal wells per year. A separate air permit will be obtained should the COP exploration project identify a viable prospect and proceed to development and production.

The Rig will be accompanied by support vessels that will assist with the exploration project. The support vessels include two icebreakers, two oil spill response vessels and associated workboats, an oil spill response tanker, two offshore supply vessels, a ware vessel¹, and a research vessel (together "Associated Fleet").

To reduce air quality impacts, combustion equipment on the Rig and Associated Fleet will utilize ultra-low sulfur diesel (ULSD) fuel. In addition, selective catalytic reduction (SCR) technology will be employed on the rig's main drilling engines and on the main and auxiliary engines on the icebreaker vessels to control Nitrogen Oxide (NOx) emissions.

The Rig has no self-propulsion capacity and will be towed to the planned drilling site. Once at the site, the Rig lowers three legs to the seabed which lift the Rig from the surface of the water to operational height. Exploratory drilling at a drill site could take a portion of the season or comprise the entire drilling season. If drilling must cease during the season for safety reasons due to ice movement too close to the rig, the Rig will be lowered, its legs raised, and towed to another location beyond the ice to wait for the ice conditions to clear before returning to the drill site to resume drilling.

¹ A "ware vessel" is a supply ship with a larger capacity than an offshore supply vessel.

If issued, the draft Title V permit will authorize emissions of air pollutants from the Rig and Associated Fleet for five years from the effective date of the permit. This document details EPA's account and basis for compliance with its obligations under section 7 of the Endangered Species Act (ESA), 16 U.S.C. §1531 *et seq.*, and section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1801 *et seq.*, as it relates to EPA's issuance of a Title V permit to COP.

II. Lead Agency for Consultation

As the agency responsible for managing the mineral resources of the Alaska OCS, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly the Minerals Management Service (MMS), leases federal lands and authorizes the exploration and development of oil and gas reserves on issued leases. In order to conduct those sales, BOEMRE prepares Environmental Impact Statements (EISs) and Environmental Assessments (EAs) as necessary. During the preparation of these materials, BOEMRE examines the environmental consequences and cumulative effects of industrial activities associated with oil and gas development and acts as the lead federal agency for consulting with the U.S. Fish and Wildlife Service (FWS or Service) and the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS or Service), collectively referred to as the Services, as required under Section 7 of the ESA and Section 305(b)(2) of the MSA.

For the oil and gas leasing and exploration activities that BOEMRE oversees in the Chukchi Sea, it initiated and completed programmatic consultations with the Services and received a Biological Opinion (BO) from NMFS on July 17, 2008, and from FWS on September 3, 2009. BOEMRE has reinitiated formal consultation with the Services to address, among other issues, the designation of polar bear critical habitat, the proposed listing of the ringed and bearded seals, and the addition of the Pacific walrus to the candidate species list.

In addressing other OCS air permit applications, EPA previously engaged in informal consultation and discussion with the Services in letters dated September 4, 2009 concerning the issuance of a CAA permit to Shell Offshore, Inc. to operate the *Frontier Discoverer* in the Chukchi Sea. These consultations and discussions addressed the potential impact of air emissions on listed, proposed, and candidate species, and designated critical habitat. The Services concurred with EPA's determination in letters dated September 23, 2009 (FWS) and October 26, 2009 (NMFS). This evaluation of air emissions is intended to compliment BOEMRE's reinitiated consultation.

III. Species Status Changes and Bowhead Whale Study

Since the conclusion of BOEMRE's last consultation with the Services, critical habitat for polar bears was designated, two ice seals (bearded and ringed seals) were proposed to be added to the list of threatened species, and the Pacific walrus was added to the list of candidate species.

- Polar bear (*Ursus maritimus*) – critical habitat designated

- Ringed seals (*Phoca hispida*) – proposed Threatened
- Bearded seals (*Erignathus barbatus nauticus*), 2 distinct population segments (DPS) – proposed Threatened
 - *Beringia DPS*
 - *Okhotsk DPS* – no known distribution in U.S. waters
- Pacific walrus (*Odobenus rosmarus divergens*) – candidate species

Designated Polar Bear Critical Habitat

On January 6, 2011 (75 FR 76086), the designated critical habitat for polar bears became effective. The designated habitat comprises three different units: sea ice, terrestrial denning, and barrier islands.

The sea ice habitat unit occurs over the continental shelf at depths of 300 meters or less and is used by polar bears for feeding, breeding, denning, and movement. The location of this habitat varies geographically depending on the time of year and weather and oceanographic conditions. During spring and summer, sea ice habitat follows the northward progression of the ice edge as it retreats northward. In fall, sea ice habitat follows the southward progression of the ice edge. Due to the impracticability of mapping sea ice, the habitat unit was established as the area within the United States used by the polar bear, and within that area, the extent of the continental shelf. In some areas the habitat boundary extends to the Exclusive Economic Zone.

Polar bears create maternal dens in snowdrifts. The terrestrial denning habitat unit includes topographic features such as coastal bluffs and river banks that provide denning habitat with suitable microhabitat characteristics including steep, stable slopes with water or relatively level ground below, unobstructed and undisturbed access between den sites and the coast, and the absence of human disturbance or activities that might attract other bears. The designated habitat extends along the northern coast of Alaska, and at varying distances inland, from Barrow to the Canadian Border.

The barrier island habitat unit is used for denning, refuge from human disturbance, and for movement along the coast to access maternal den and optimal feeding habitat. Polar bears use barrier islands as migration corridors and move freely between the islands by swimming or walking on ice or shallow sand bars. Although less dynamic than sea ice barrier islands constantly shift due to erosion and deposition. However, the location of barrier islands generally parallels the mainland coast of Alaska. Designated barrier island habitat includes off-shore islands from the Canadian border westward and southward to Hooper Bay, and includes ice, water, and terrestrial habitat within 1 mile of the mean high tide line of the barrier islands.

The final rule designating polar bear critical habitat identified petroleum hydrocarbons as a source of pollution that could render areas containing identified physical and biological features unsuitable for use by polar bears. The greatest risk to habitat from petroleum hydrocarbons associated with oil and gas exploration and development is from the potential effect of an oil spill or discharge into the marine environment. Combustion of petroleum hydrocarbons was not specifically identified in the final rule as a pollution threat to polar bear critical habitat.

Although BOEMRE has reinitiated consultation with FWS on the polar bear's designated critical habitat, EPA notes that BOEMRE evaluated this issue as part of a conference with FWS after the proposed rule to designate critical habitat in October 2009. On December 3, 2009, BOEMRE sent to FWS an evaluation that concluded the total effect of proposed drilling activities would not result in the adverse modification of the physical or biological features essential to the conservation of the proposed polar bear critical habitat. The evaluation further explained mitigation measures that would help ensure that no adverse modification occurs. These mitigation measures include limiting ice disturbance to a minimum; development and implementation of a comprehensive oil discharge prevention and contingency plan; and conditions on vessel operations specifying that vessels will use transit routes more than 25 miles offshore, not operate within 0.5 miles (800 m) of polar bears observed on land or sea ice, and follow specific corridors at least 1 mile from barrier islands.

With respect to potential operational impacts apart from air emissions, EPA intends to rely, as appropriate, on the conclusions of BOEMRE as the lead federal agency and its ongoing communications with FWS to ensure ESA compliance. Further information on the polar bear and its critical habitat can be found in the previously issued FWS BOs and Shell's May 2011 Revised Camden Bay Exploration Plan and Environmental Impact Analysis.

Ringed and Bearded Seals Proposed for Listing as Threatened Species

On December 10, 2010, NMFS proposed to list ringed seals (*Phoca hispida*) (75 FR 77476) and two distinct populations (DPS) of the subspecies of the bearded seal (*Erignathus barbatus*) as threatened under the ESA (75 FR 77496). As of the date of this analysis, NMFS has not issued a final decision on either proposal. However, as previously mentioned, BOEMRE is conferring with NMFS to address the proposed listing of the ring and bearded seals and EPA intends to rely on the conclusions of that conference, as appropriate, with respect to potential impacts from ConocoPhillips' activities apart from air emissions.

Ringed Seals

The ringed seal (*Phoca hispida*) is the smallest of the northern seals, with typical adult body sizes of 1.5 m in length and 70 kg in weight. The average life span of ringed seals is about 15–28 years. As the common name of this species suggests, its coat is characterized by ring-shaped markings. Ringed seals are adapted to remaining in heavily ice-covered areas throughout the fall, winter, and spring by using the stout claws on their fore flippers to maintain breathing holes in the ice.

The seasonality of ice cover strongly influences ringed seal movements, foraging, reproductive behavior, and vulnerability to predation. There are three ecological seasons recognized for ringed seals: "open water or foraging period" when ringed seals forage most intensively; early winter through spring when seals rest primarily in subnivean lairs on the ice, referred to as the "subnivean period;" and the period between abandonment of the lairs and ice break-up, referred to as the "basking period."

Bearded Seals

The bearded seal exists as two subspecies, *E.b. nauticus* (Pacific sector) and *E.b. barbatus* (Atlantic sector). Based on its review, NMFS concluded that two DPS of the *E. b. nauticus*

species, commonly inhabiting the Pacific sector, are likely to become endangered throughout all or a significant portion of their ranges in the foreseeable future. The two DPS are the Beringia DPS, and the Okhotsk. The Okhotsk DPS are not found in U.S. waters. The Beringia DPS is found throughout the Bering and Chukchi Seas where the shallow continental shelf provides the seals favorable foraging habitat.

As the ice retreats in the spring most adult bearded seals in the Bering Sea are thought to move north through the Bering Strait, where they spend the summer and early fall at the southern edge of the Chukchi and Beaufort Sea pack ice and at the wide, fragmented margin of multi-year ice. As the ice forms again in the fall and winter, most seals move south with the advancing ice edge through Bering Strait and into the Bering Sea where they spend the winter.

As mentioned, ConocoPhillips' proposed operations are restricted to the open water season of July through November and will be located at least 60 miles from the nearest point on the Alaskan coast. The impacts from air pollutants associated with these operations will be largely limited to this same period and are expected to dissipate rapidly when operations cease. During the permitted period of operations, the majority of bearded and ringed seals in the Chukchi Sea are expected to be at the southern edge of the ice pack or on shorefast ice.

Pacific Walrus Added as Candidate Species

On February 10, 2011, the FWS designated the Pacific walrus (*Odobenus rosmarus divergens*) as a candidate species for listing as threatened or endangered (76 FR 7634). As a matter of discretion, EPA is considering potential air emissions impacts to the Pacific walrus given its at-risk status and in case the Pacific walrus is eventually added to the list of threatened or endangered species.

New Evidence of Bowhead Whales Olfactory System

NMFS informed Region 10 during the April 11, 2011 discussion that new information on the bowhead whales indicates that bowhead and other non-toothed whales have an olfactory system and a sense of smell that can be used to find aggregations of krill on which they feed. At NOAA's request, EPA conducted a literature search to see if there exists any additional information that might indicate whether the air emissions from the exploratory drilling could have an impact on the endangered whales. While we did find a study discussing the effects of engine exhaust on orca whales², no information specific to bowhead whales was located.

Given this lack of information, the limited extent and duration of any direct exposure of bowhead whales to the air emissions, and the limited extent and duration of any changes to marine chemistry that may be caused by the air emissions, EPA does not believe the emissions would have adverse effects on bowhead olfaction. Accordingly, EPA has determined that air emissions are not expected to have measurable adverse effects on bowhead whales.

IV. Potential Impact from Air Emissions

² Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds, Lachmuth, C.L., Barrett-Lennard, L. G.-B., Steyn, D.Q., Milsom, W.K., Marine Pollution Bulletin, Volume 62, Issue 4, April 2011, at 792-805.

While consultations and conferences between BOEMRE and the Services will address the impacts to critical habitat and proposed and candidate species from the exploratory drilling and associated activities apart from air emissions, EPA provides the following information concerning the effects of our permitted action.

Air Pollutant Emissions

Air pollutant emissions from the Rig and Associated Fleet were considered, along with background air pollution concentrations, to estimate worst-case air pollution concentrations that could occur during the permitted operations. The air quality modeling results for the Rig and Associated Fleet are provided in Table 1. Further information on the air quality analysis can be found in ConocoPhillips' air permit application, the Statement of Basis accompanying the draft permit, and EPA's Review of Ambient Air Quality Impact Analysis. The Statement of Basis and Ambient Air Quality Impact Analysis are available on EPA's website at <http://yosemite.epa.gov/R10/airpage.nsf/permits/ocsap/>.

Table 1: Ambient Air Quality Standards and Maximum Ambient Air Pollution Levels Estimated to Result from COP's Exploratory Drilling Operations in the Chukchi Sea

Pollutant*	Averaging Time	National Ambient Air Quality Standard (µg/m3)	Maximum Estimated Pollution Levels** (µg/m3)
Nitrogen Dioxide (NO ₂)	1-hour	188	183.70
	Annual	100	12.04
Particulate Matter (PM _{2.5})	24-hour	35	31.40
	Annual	15	2.70
Particulate Matter (PM ₁₀)	24-hour	150	112.20
Carbon Monoxide (CO)	1-hour	40,000	4,160.00
	8-hour	10,000	2168.00

* SO₂ concentration impacts are predicted to be less than their significant impact levels and are not shown here.

** Maximum estimated pollution levels are derived by adding the increase in air pollutant emissions expected to result from COP's activities to existing background concentrations of air pollution and regional sources. The worst case emissions scenarios from COP's operations are used as inputs to air quality models to derive the maximum estimated pollution levels. Note: The maximum levels occur very close to the Rig (at the ambient air boundary) and decrease as distance from the Rig increases.

Current air quality in the project area attains EPA's National Ambient Air Quality Standards (NAAQS) and is expected to continue to do so. EPA's permit would authorize additional emissions of air pollutants from the exploratory drilling and associated activities and the maximum increase in pollution levels (see Table 1) expected to result from these emissions were calculated for the ambient air boundary considered to be the 500 meters from the center of the COP drill rig.

To estimate the maximum air pollutant levels from the COP vessel's and its associated fleet, the modeling emissions scenario was developed with the ice management fleet operating upwind of the COP vessel to break up or redirect any ice if necessary, and the OSR fleet operating downwind of the COP vessel in the direction which any oil spill would drift. The impact analysis also includes the emissions of the resupply vessel in transit within 25 miles of the COP vessel.

The ice management fleet, OSR fleets and resupply ship in transit are characterized in the air quality impact analysis using an elevated line source (series of adjacent volume sources) at the nearest edge of anticipated activity to the COP vessel. This configuration represents a worst-case scenario since, in reality, the ice management fleet will be breaking up ice at and beyond the nearest edge of anticipated ice management activity (e.g., further away from the COP vessel). The line source characterization is designed to simulate the effect of mobile sources moving around and emitting plumes which rise and form a layer of emissions above ground (e.g., smearing in space of a plume from a moving ship) which is then advected downwind towards the COP vessel. This design simulates the effect of ice management fleet under its highest emitting scenario, which is a continual churning up of one-year ice drifting toward the COP vessel. Current air quality in the project areas attains EPA's National Ambient Air Quality Standards (NAAQS) and this is expected to continue to be the case. EPA's permit would authorize additional emissions of air pollutants from the exploratory drilling and associated activities. See Table 1 above for pollution levels expected to result from these activities when added to current background levels.

As noted in Table 1, the maximum estimated pollutant levels (background concentration plus COP contribution) are below the Primary and Secondary NAAQS. EPA developed the NAAQS for pollutants considered harmful to human health and the environment. Primary standards set limits to protect human health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, and vegetation. Since the modeling indicates that the NAAQS will be met at the ambient air boundary (500 meters from the hull of the Rig), air pollutant impacts are expected to be negligible, localized, short-term, and dissipate rapidly when drilling operations cease. Accordingly, EPA believes the air emissions will not have an adverse effect on the conservation function of sea ice, barrier islands, and denning habitats identified as essential to polar bear recovery. The anticipated emissions of key pollutants include nitrogen oxides (NO_x) and particulate matter (PM); EPA is not aware of any toxicity information on these pollutants specific to the polar bear's critical habitat.

For similar reasons, based on a review of the proposed listings for the ice seals and the determination that listing is warranted for the walrus, as well as the scientific literature search EPA previously conducted for listed species, EPA believes the air emissions will also not have adverse effects on the ice seals or walrus.

EPA found no references to literature regarding the potential impacts from air pollutant inhalation or exposure to ambient concentrations of the specific air emissions anticipated from the operation of the Rig and Associated Fleet. Additionally, the FWS' Range-Wide Status Review of the Polar Bear found that the three main groups of contaminants in the Arctic thought

to present the greatest potential threat to marine mammals are petroleum hydrocarbons, persistent organic pollutants, and heavy metals.

Diesel-fired combustion units are not expected to release persistent organic pollutants or substantive quantities of heavy metals. EPA concluded that while the combustion of fossil fuels emits petroleum hydrocarbons, the most direct exposure to threatened and endangered marine species comes from direct contact and ingestion of oil from acute and chronic oil spills. Therefore, the greater risk to threatened and endangered marine species from oil and gas development in the Arctic are from the potential for increased oil and fuel spills rather than emissions of petroleum hydrocarbons from the combustion of fossil fuels.

Emissions of air pollutants will also be minimized by conditions contained in the draft air permits. These conditions include hourly and seasonal limits on operations, requirements to use ultra-low sulfur diesel, and installation and operation of pollution controls. The Services previously concluded that the proposed air emissions from the Shell Discoverer Chukchi Sea drilling activities would have no measurable or adverse effects to species or critical habitat, above those already considered in previous consultations. The COP Rig and Associated Fleet involve operations and emissions similar to that of the Shell Discoverer, and emissions from both operations are expected to comply with Primary and Secondary NAAQS.

Duration and Extent of Exploratory Drilling

The BOs discussed above anticipate that exploratory drilling activity will be limited to an “open water” period generally described as July through November in the Chukchi Sea, although annual variations may occur. If issued, EPA’s air permit would authorize exploratory drilling between July 1 and November 30. This authorization is consistent with the presumed open water season in the Chukchi Sea. However, the actual drilling authorization period will be established by BOEMRE’s approval of exploration drilling. Therefore, it is BOEMRE’s approval that ultimately limits actual drilling activities in the area. EPA’s permits will include conditions that require COP to comply with any other applicable Federal and state regulations.

COP’s permit application states that the initial drilling program will be conducted over a maximum of 100 days during the first year of exploration. If a significant accumulation of hydrocarbons is discovered, exploratory operations in subsequent years will involve drilling one to three appraisal wells per drilling season. The extent of exploratory drilling considered in the BOs discussed above ranged from completion of two to four wells per drilling season. Thus, the predicted extent of COP’s exploratory well drilling is generally consistent with the extent of exploratory drilling assumed by the Services in the BOs.

V. Essential Fish Habitat

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with NMFS with respect to any action authorized, funded, or undertaken by the agency that may adversely affect any essential fish habitat (EFH) identified under the MSA, 16 U.S.C. § 1855(b)(2), and implementing regulations at 50 CFR § 600.920. For activities that may have an adverse effect on EFH, agencies must provide NMFS with a written assessment of those effects unless the agency determines that the action would not adversely affect EFH. 40 C.F.R. § 600.920(e)(1).

BOEMRE is the lead Federal agency for authorizing oil and gas exploration activities on the Alaskan OCS, including the Beaufort Sea and the Chukchi Sea. In accordance with the MSA, BOEMRE consults on EFH at the oil and gas lease sale stage and consulted with NMFS in connection with Lease Sale 193 in the Chukchi Sea. BOEMRE received NMFS' conservation recommendations pursuant to Section 305(b)(4)(A) in a letter dated January 30, 2007. BOEMRE considered these recommendations in making its final determination on Lease Sale 193.

In August 2009, EFH was designated for three species – saffron cod, Arctic cod, and Opillio crab. To address MSA consultation requirements for the newly designated EFH, BOEMRE is preparing a separate EFH assessment to be delivered to NMFS in the summer of 2011. Any conservation recommendations resulting from that consultation will be addressed in BOEMRE's Final Environmental Impact Statement for Lease Sale 193.

Based on review and consideration of the information described above, EPA believes that the levels of air pollutant emissions authorized by our permits will have no effect on EFH. Therefore, EPA defers to BOEMRE as the lead agency consulting with NMFS on EFH for oil and gas exploration in the Chukchi Sea under Lease Sale 193.

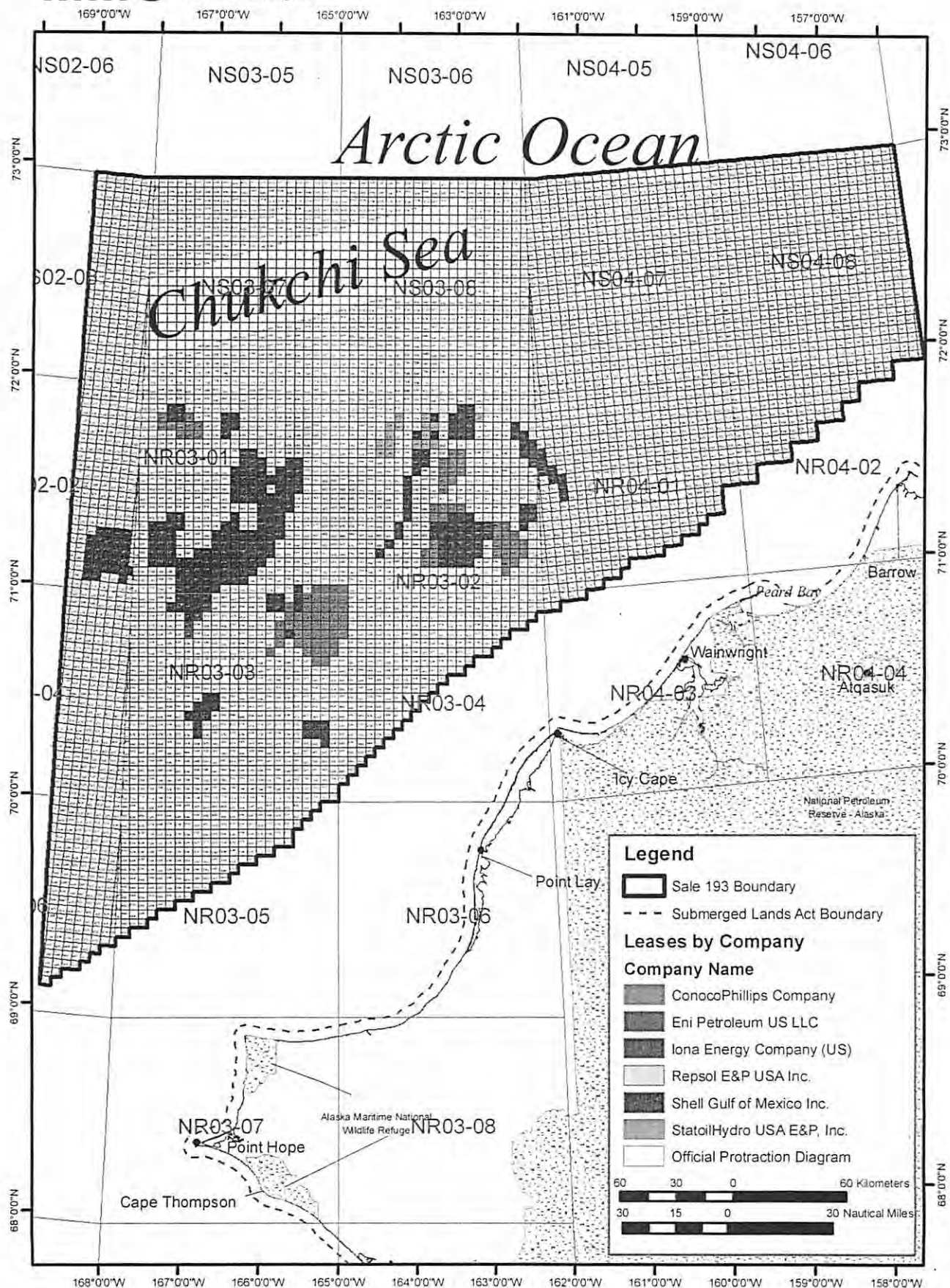
VI. Conclusion

EPA has determined that no likely adverse effects on polar bear critical habitat, proposed ice seals, or candidate walrus will occur from air emissions authorized by EPA's CAA permits. EPA has also determined that new information on the potential susceptibility of bowhead whales to air emissions does not warrant reinitiation of previously-completed consultation. Accordingly, EPA anticipates no adverse effects on polar bear critical habitat or the relevant species beyond those considered by BOEMRE and the Services' in completed and ongoing consultation, conference, and coordination efforts addressing these important resources.

Appendix B
2011 Arctic Region Biological Evaluation

MMS

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region





**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10**

1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR, WASTE AND TOXICS

JUL 25 2011

Mr. Fred King
Acting Regional Supervisor
Office of Leasing and Environment
Alaska Outer Continental Shelf Region
Bureau of Ocean Energy Management
Regulation and Enforcement
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503

Dear Mr. King:

This letter is a continuation of our informal discussions with your staff regarding the Clean Air Act (CAA) permits we are proposing to issue to Shell Offshore Inc. and Shell Gulf Of Mexico Inc. (collectively "Shell") for exploratory drilling in the Chukchi and Beaufort Seas.

This letter transmits two cover letters and an analysis sent by Region 10 of the Environmental Protection Agency (EPA) to the U.S. Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration Fisheries Service (NMFS) (collectively "the Services") concerning the potential effects of EPA's CAA permitting actions on Endangered Species Act (ESA) listed and proposed species and their designated critical habitat.

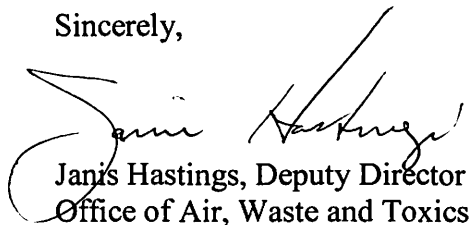
As explained in more detail in the attached letters, in 2010 we completed informal discussions with the Services regarding two CAA Outer Continental Shelf (OCS) permits issued to Shell in 2010 to operate the Frontier Discoverer (now Noble Discoverer) in the Beaufort and Chukchi Seas. These permits were appealed to the Environmental Appeals Board (Board). The Board remanded the 2010 permits for further consideration. The ESA conclusions were not a basis for appeal of the permits.

On July 6, 2011, EPA proposed and requested public comment on a draft revised permit for Shell to operate the Noble Discoverer in the Beaufort and Chukchi Seas. Public comment on this permit closes on August 6, 2011. Additionally, in February 2011, Shell submitted an application for an OCS/minor source permit to conduct exploratory operations on specified lease blocks in the Beaufort Sea using the Kulluk, a non self propelled drill rig. On July 22, 2011, EPA proposed and requested public comment on a draft CAA permit for Shell to operate the Kulluk in the Beaufort Sea. Public comment on this permit closes on September 6, 2011.

In previous discussions between FWS and several federal agencies, including EPA and BOEMRE, it was acknowledged that BOEMRE will continue as the lead agency for exploratory oil and gas operations in the Arctic and that EPA may continue to rely on its consultations. FWS specifically indicated that this approach is still acceptable. FWS also suggested that we copy BOEMRE on our correspondence and accompanying analysis with the Services regarding the exploration activities in the Arctic and that we ask BOEMRE to include our analysis and information about the CAA permits in its consultations with the Services. We understand that

BOEMRE is in the process of updating its consultation to reflect the new exploration plan submitted by Shell and is considering recent ESA-related regulatory changes and new information since the previous consultation was conducted for Shell's operations in the Chukchi and Beaufort Seas. Accordingly, we request that you include our attached analysis and information about the CAA permits in your consultations with the Services. If you need any additional information please call me at 206-553-1582 or Madonna Narvaez at 206-553-2117.

Sincerely,



Janis Hastings, Deputy Director
Office of Air, Waste and Toxics

Enclosures

1. Letter to Mr. Ted Swem and Ms. Rosa Meehan, U.S. Fish and Wildlife Service
2. Letter to Ms. Kaja Brix, National Marine Fisheries Service
3. Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA) Section 7 and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Section 305(b)(2) Determinations for Shell Offshore, Inc. and Shell Gulf of Mexico, Inc. Beaufort and Chukchi Sea Exploration Drilling Program Air Permits – Noble Discoverer and Kulluk

cc: James Lima,
Chief, Environmental Analysis Section
BOEMRE, Anchorage

Mark Schroeder,
BOEMRE, Anchorage



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR, WASTE AND TOXICS

JUL 25 2011

Mr. Ted Swem
Endangered Species Branch Chief
US Fish and Wildlife Service
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

Ms. Rosa Meehan, Supervisor
US Fish and Wildlife Service
Marine Mammals Management
1011 East Tudor Road, MS 341
Anchorage, Alaska 99503

Dear Mr. Swem and Ms. Meehan:

With this letter, Region 10 of the Environmental Protection Agency (EPA) transmits its evaluation of the potential effects of air permits issued under the Clean Air Act (CAA) on candidate species and designated critical habitat, and requests your concurrence with its conclusions. This letter is part of EPA's ongoing informal discussions with your staff regarding CAA permits that will authorize air emissions from Shell Offshore Inc. and Shell Gulf of Mexico Inc. (collectively "Shell") exploratory drilling operations on the Outer Continental Shelf (OCS) in the Chukchi and Beaufort Seas.

In April and March 2010, EPA issued two OCS Prevention of Significant Deterioration (PSD) permits to Shell to construct and operate the Discover drillship and its associated fleet in the Beaufort and Chukchi Seas (together "2010 PSD Permits"). The final 2010 PSD Permits were appealed to the Environmental Appeals Board (EAB). The EAB remanded the 2010 PSD Permits for further consideration. EPA's ESA determinations were not a basis for appeal or remand of the 2010 PSD Permits.

Subsequent to the remand, Shell provided new and additional information regarding its proposed operations in the Beaufort and Chukchi Seas. On July 6, 2011, EPA proposed and released for public comment revised draft PSD permits (2011 Revised Draft Permits) for the Shell to construct and operate the Discoverer in the Beaufort and Chukchi Seas commencing in July 2012. The public comment period for these permits closes on August 5, 2011. The location and general scope of the activities authorized under the 2011 Revised Draft Permits have not changed, although emissions have been reduced significantly as a result of a shortened drilling season and the installation of additional air pollution controls.

In February 2011, Shell submitted an application for an OCS/minor source permit to construct and operate the Kulluk, a non-self propelled conical drilling unit, to conduct exploratory drilling operations on specified lease blocks in the Beaufort Sea. Similar to the Discoverer, the Kulluk will be accompanied by an associated fleet of support vessels consisting of icebreakers, resupply vessels and tugs, and oil spill response vessels. In order to remain a minor source under the CAA, and thereby avoid PSD permitting requirements, the draft OCS/minor source permit will preclude Shell from operating the Kulluk in the Beaufort Sea if the Discoverer operates in the Beaufort Sea during the same drilling season. The draft OCS/minor source permits for the Kulluk were proposed and public comment requested on July 22, 2011. The public comment period closes on September 6, 2011.

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is the lead agency consulting with FWS on oil and gas exploratory drilling operations in the Beaufort and Chukchi Seas. In addition to the completed and ongoing consultations between BOEMRE and FWS, EPA initiated informal discussions with your staff concerning the 2010 PSD Permits by transmitting its analysis that the limited air emissions authorized by the permit would not adversely affect listed species or critical habitat under FWS jurisdiction. FWS concurred with EPA's determination in letters dated September 23, 2009 and April 5, 2010. We appreciate your cooperation and timely responses with respect to the 2010 PSD Permits.

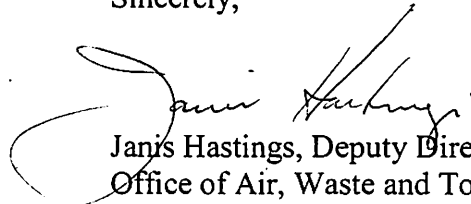
Shell's currently planned activities for the Discoverer and the Kulluk are similar to those described in the informal discussions concerning the 2010 PSD Permits. However, there have been a number of significant changes to Shell's proposed exploratory operations as they pertain to air emissions. These changes include the OCS/minor source permit for the Kulluk, a reduction in the days of operation from 168 to 120 days, and the inclusion of additional air pollution controls for the Discoverer.

Since the 2010 PSD Permits, there have also been a number of ESA-related regulatory changes. These changes include the designation of polar bear critical habitat and the addition of Pacific walruses to the list of candidate species. The evaluation enclosed with this letter analyzes factors specific to the CAA permit, including specific air emission information, changes from the previous permits, and the additional permit for the Kulluk, as these factors relate to the recent ESA-related regulatory changes described above. The evaluation provides EPA's basis for concluding that air emissions from Shell's exploratory drilling in the Beaufort and Chukchi Seas, as authorized and regulated by the draft CAA permits, would have no adverse effects on polar bear critical habitat or Pacific walruses.

EPA's evaluation is intended to supplement BOEMRE's ongoing consultations with FWS to address Shell's revised exploration plan and ESA regulatory changes. We have requested that BOEMRE consider and include information contained in the enclosed analysis during its ongoing consultations. The draft CAA permits do not relieve Shell from its obligation to comply with other applicable state and federal requirements, including requirements, as appropriate, to obtain annual letters of authorization or other applicable authorizations or approvals.

EPA is requesting that FWS concur in writing with our conclusions. We would appreciate your response by August 19, 2011, if possible. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or Madonna Narvaez at 206-553-2117.

Sincerely,



Janis Hastings, Deputy Director
Office of Air, Waste and Toxics

Enclosure

1. Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA) Section 7 and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Section 305(b)(2) Determinations for Shell Offshore, Inc. and Shell Gulf of Mexico, Inc. Beaufort and Chukchi Sea Exploration Drilling Program Air Permits – Noble Discoverer and Kulluk

cc: Shannon Torrence
USFWS Field Office
Fairbanks

Craig Perham
USFWS, Marine Mammals Management
Anchorage

Mark Schroeder,
BOEMRE, Anchorage



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR, WASTE AND TOXICS

JUL 25 2011

Ms. Kaja Brix
Assistant Regional Administrator
Protected Resources Division
National Marine Fisheries Service
Alaska Region
709 West 9th Street
P.O. Box 21668
Juneau, Alaska 99802-1668

Dear Ms. Brix:

With this letter Region 10 of the Environmental Protection Agency transmits its evaluation of the potential effects of air permits issued under the Clean Air Act (CAA) on proposed and listed species, and requests your concurrence with its conclusions. This letter is part of EPA's ongoing informal discussions with your staff regarding CAA permits that will authorize air emissions from Shell Offshore Inc. and Shell Gulf Of Mexico Inc. (collectively "Shell") exploratory drilling operations on the Outer Continental Shelf (OCS) in the Chukchi and Beaufort Seas.

In April and March 2010, EPA issued two OCS Prevention of Significant Deterioration (PSD) permits to Shell to construct and operate the Discover drillship and its associated fleet in the Beaufort and Chukchi Seas (together "2010 PSD Permits"). The final 2010 PSD Permits were appealed to the Environmental Appeals Board (EAB). The EAB remanded the 2010 PSD Permits for further consideration. EPA's ESA determinations were not a basis for appeal or remand of the 2010 PSD Permits.

Subsequent to the remand, Shell provided new and additional information regarding its proposed operations in the Beaufort and Chukchi Seas. On July 6, 2011, EPA proposed and released for public comment revised draft PSD permits (2011 Revised Draft Permits) for the Shell to construct and operate the Discoverer in the Beaufort and Chukchi Seas commencing in July 2012. The public comment period for these permits closes on August 5, 2011. The location and general scope of the activities authorized under the 2011 Revised Draft Permits have not changed, although emissions have been reduced significantly as a result of a shortened drilling season and the installation of additional air pollution controls.

In February 2011, Shell submitted an application for an OCS/minor source permit to construct and operate the Kulluk, a non-self propelled conical drilling unit, to conduct exploratory drilling operations on specified lease blocks in the Beaufort Sea. Similar to the Discoverer, the Kulluk will be accompanied by an associated fleet of support vessels consisting of icebreakers, resupply vessels and tugs, and oil spill response vessels. In order to remain a minor source under the

CAA, and thereby avoid PSD permitting requirements, the draft OCS/minor source permit will preclude Shell from operating the Kulluk in the Beaufort Sea if the Discoverer operates in the Beaufort Sea during the same drilling season. The draft OCS/minor source permits for the Kulluk were proposed and public comment requested on July 22, 2011. The public comment period closes on September 6, 2011.

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is the lead agency consulting with NMFS on oil and gas exploratory drilling operations in the Beaufort and Chukchi Seas. In addition to the completed and ongoing consultations between BOEMRE and NMFS, EPA initiated informal discussions with your staff concerning the 2010 PSD Permits by transmitting its analysis that the limited air emissions authorized by the permit would not adversely affect listed species under NMFS jurisdiction. NMFS concurred with EPA's determination in letters dated October 26, 2009 and March 30, 2010. We appreciate your cooperation and timely responses with respect to the 2010 PSD Permits.

Shell's currently planned activities for the Discoverer and the Kulluk are similar to those described in the informal discussions concerning the 2010 PSD Permits. However, there have been a number of significant changes to Shell's proposed exploratory operations as they pertain to air emissions. These changes include the OCS/minor source permit for the Kulluk, a reduction in the days of operation from 168 to 120 days, and the inclusion of additional air pollution controls for the Discoverer.

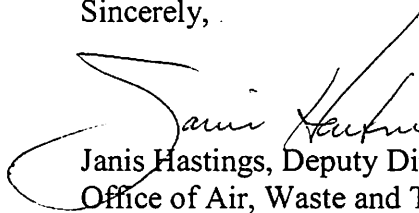
Since the 2010 PSD Permits, there have also been a number of ESA-related regulatory changes. These changes include the proposal to list as threatened ringed seals and two subspecies of bearded seals, and the identification of possible impacts to the olfactory system of endangered bowhead whales. The evaluation enclosed with this letter analyzes factors specific to the CAA permit, including specific air emission information, changes from the previous permits, and the additional permit for the Kulluk, as these factors relate to the recent ESA-related regulatory changes described above. The evaluation provides EPA's basis for concluding that air emissions from Shell's exploratory drilling in the Beaufort and Chukchi Seas, as authorized and regulated by the draft CAA permits, would have no adverse effects on proposed bearded and ringed seals or the olfactory system of the bowhead whale.

BOEMRE also completed and is conducting ongoing consultations with NMFS concerning the effects of Shell's drilling operations on essential fish habitat. The enclosed evaluation also includes EPA's conclusion that the issuance of the air permits will have no effect on essential fish habitat.

EPA's evaluation is intended to supplement BOEMRE's ongoing consultations with NMFS to address Shell's revised exploration plan and ESA regulatory changes. We have requested that BOEMRE consider and include information contained in the enclosed analysis during its ongoing consultations. The draft CAA permits do not relieve Shell from its obligation to comply with other applicable state and federal requirements, including requirements, as appropriate, to obtain annual letters of authorization or other applicable authorizations or approvals.

EPA is requesting that NMFS concur in writing with our conclusions. We would appreciate your response by August 19, 2011, if possible. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or Madonna Narvaez at 206-553-2117.

Sincerely,



Janis Hastings, Deputy Director
Office of Air, Waste and Toxics

Enclosure

1. Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA) Section 7 and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Section 305(b)(2) Determinations for Shell Offshore, Inc. and Shell Gulf of Mexico, Inc. Beaufort and Chukchi Sea Exploration Drilling Program Air Permits – Noble Discoverer and Kulluk

cc: Brad Smith
NMFS, Anchorage

Mark Schroeder
BOEMRE, Anchorage

**Evaluation and Basis for EPA Region 10's Endangered Species Act (ESA)
Section 7 and Magnuson-Stevens Fishery Conservation and Management Act
(MSA) Section 305(b)(2) Determinations for the Shell Offshore Inc. and Shell
Gulf of Mexico, Inc. Beaufort and Chukchi Seas Exploration Drilling
Program Air Permits – Noble Discoverer and Kulluk**

I. Background

On March 31, 2010, the EPA Region 10 (EPA) issued an Outer Continental Shelf (OCS)/Prevention of Significant Deterioration (PSD) Permit to Construct, to Shell Gulf of Mexico, Inc.'s (SGOMI) for operations in the Chukchi Sea. On April 9, 2010, Region 10 issued another OCS/PSD Permit to Construct, to Shell Offshore, Inc. (SOI) for operations in the Beaufort Sea. These permits (2010 Permits) authorized SGOMI and SOI (collectively, "Shell") to construct and operate the Frontier Discoverer drillship (Discoverer)¹ and its air emission units to conduct air pollutant emitting activities for the purpose of oil exploration on specified lease blocks in the Chukchi and Beaufort Seas off the North Slope of Alaska as authorized by the United States Bureau of Ocean and Energy Management, Regulation and Enforcement (BOEMRE).² Both 2010 Permits provided for the use of the Discoverer drill ship and an associated fleet of support ships (Associated Fleet), such as icebreakers, oil spill response vessels, and a supply ship. OCS/PSD permits are governed by section 328 of the Clean Air Act (CAA), 42 U.S.C. 7627, and EPA's implementing regulations at 40 C.F.R. Part 55 and the procedural rules set forth in 40 C.F.R. Part 124. See 40 C.F.R. § 55.6(a)(3).

Following petitions for review to the Environmental Appeals Board (EAB or Board), the Board remanded the 2010 Permits back to Region 10 for further consideration on several issues. The Endangered Species Act (ESA) conclusions were not a basis for appeal of the permits. Following the Board's remand, Region 10 reevaluated the permits and proposed revised draft permits on July 6, 2011 for operation commencing in July 2012. The location and general scope of activities authorized under these 2011 Revised Draft Permits have not changed, although the period of operation authorized by the permits has been shortened at Shell's request, and the Revised Draft Permits now require installation of selective catalytic reduction and oxidation catalyst emission controls on the largest emission units (main propulsion engine and generators) on Icebreaker #1..

¹ The Frontier Discoverer has since been renamed "The Noble Discoverer" and will be referred to in this document as "the Discoverer." Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska, Flaxman Island Blocks 6659, 6610, 6658, Beaufort Sea Lease Sales 195 and 202, May 4, 2011.

² The Secretary of the U.S. Department of the Interior (DOI) regulates and manages the development of mineral resources on the OCS. See 43 U.S.C. § 1334 (authorizing Secretary to administer leasing on the OCS). In particular, BOEMRE is responsible for overseeing the safe and environmentally responsible development of energy and mineral resources on the OCS. BOEMRE was established as a result of Secretarial Order 3302, signed on June 18, 2010, by the Secretary of the Interior. Secretary of the Interior, U.S. Department of the Interior, Secretarial Order No. 3302, *Change of the Name of the Minerals Management Service to the Bureau of Ocean Energy management, Regulation and Enforcement* (June 18, 2010), available at http://elips.doi.gov/app_so/index.cfm?fuseaction=chroList/.

In February 2011, Shell submitted an application to EPA for an OCS/minor source permit to conduct exploratory operations on specified lease blocks in the Beaufort Sea using the Kulluk, a non-self propelled conical drilling unit. Similar to the Discoverer operations, the Kulluk will be accompanied by an associated fleet of support vessels such as icebreakers, tugs and oil spill response and resupply vessels. According to the application, the Kulluk will operate only in the Beaufort Sea. EPA intends to issue a proposed draft permit for the Kulluk in the near future for operation commencing in July 2012.

Because the exploratory operations to be conducted by the Discoverer are similar to the operations to be conducted by the Kulluk, this evaluation covers the Discoverer drillship and its associated fleet's activities in Chukchi and Beaufort Sea, as well as the Kulluk and its associated fleet's activities in the Beaufort Sea.

EPA held discussions with NOAA on April 11, 2011, and with FWS and other federal agencies on June 1, 2011.³ Consistent with these discussions, this evaluation is intended to supplement previous analysis and consultation regarding Shell's OCS activity in the Arctic and therefore only discusses changes that have occurred since issuance of the 2010 permits. EPA's prior analysis and responses from the Services are attached as Appendix B through E.

This evaluation discusses changes to the Revised Draft Permits, regulatory changes, and addresses issues raised during the April 11 and June 1 discussions. This evaluation also includes discussion of the Kulluk drilling unit which is proposed for operation in the Beaufort Sea.

The notable regulatory changes include the designation of polar bear critical habitat, the proposed listing of the bearded and ringed seals as threatened, and the addition of the Pacific walrus to the candidate species list. This evaluation also considers possible impacts from air emissions on the olfactory system of endangered bowhead whales, an issue raised by NOAA during discussions with EPA. The ESA requires consultation with the relevant Service if an agency action may affect designated critical habitat. The ESA also requires that agencies confer with the Service if an action is likely to jeopardize a species proposed for listing. Potential effects on candidate species do not trigger substantive or procedural ESA duties; however, as a matter of discretion agencies may consider such effects in light of the species at-risk status or to avoid future conflicts if the species is eventually listed as threatened or endangered. Finally, where a new study or information reveals effects of an action not previously considered, the ESA regulations require reinitiation of consultation.

As it did for the 2010 permits, Shell proposes to operate the Discoverer drillship and associated fleet within and beyond 25 miles of the Alaska seaward boundary in the Beaufort Sea, and beyond 25 miles from the Alaska seaward boundary in the Chukchi Sea. The Revised Draft Permits reduce the total days of operation authorized under the

³ Teleconference calls: EPA and NOAA, April 11, 2011; EPA and FWS, BOEMRE, BLM, and COE, June 1, 2011.

permit from 168 to 120 days, and shorten the drilling season from July 1 through December 31 to July 1 through November 30. The Revised Draft Permits also include new limits on emissions of greenhouse gases from the Discoverer and Associated Fleet such that emissions remain below major source thresholds, and substantial reductions in emissions from the main propulsion engines and generators on Icebreaker #1 through the installation of post combustion controls consisting of selective catalytic reduction (SCR) and oxidation catalyst. The installation of SCR and oxidation catalyst will reduce annual nitrogen oxide (NO_x) emissions from 850 to 41.5 tons per year (tpy) and daily emissions of Particulate Matter (PM) from 1098 to 277 pounds per day. As a result of these and other limits imposed in the Revised Draft Permit, overall annual emissions of key pollutants will be decreased by 50%, with a small increase in ammonia (0.18 tpy) resulting from the installation of SCR on Icebreaker #1.

The Kulluk is a non self-propelled conically shaped, ice-strengthened floating drilling unit designed and constructed for drilling operations in Arctic waters. The Kulluk will operate within and beyond 25 miles of the Alaska seaward boundary in the Beaufort Sea. Operation will only be allowed at certain sites within lease blocks for which Shell has received an authorization to drill from BOEMRE. Appendix A contains maps showing the lease blocks where Shell proposes to conduct exploratory drilling operations in the Beaufort Sea.

To operate the Kulluk, Shell applied for a minor source air permit under Alaska state regulations and a federal Title V operating permit under the CAA. These permits will be combined into a single Title V permit issued by EPA. The draft Title V permit includes limits to ensure that emissions from the Kulluk and Associated Fleet remain below major source thresholds.⁴ Like the Revised Draft Permits for the Discoverer, the Kulluk draft Title V permit authorizes an operational period of 120 day between July 1 and November 30. The permit will also include a condition that will prohibit the Kulluk from operating in the Beaufort Sea at the same time another Shell permitted drill rig or vessel is operating as an OCS source in the Beaufort Sea.

The Kulluk (under tow) or the Discoverer (under its own propulsion) and their Associated Fleets will transit through the Bering Strait into the Chukchi or Beaufort Sea on or about July 1. Exploration drilling activities at the drill sites are planned to begin on July 10 and run through October 31. In the exploration plan submitted to BOEMRE, Shell states that it will suspend all operations in the Beaufort Sea beginning August 25 for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale harvests. During the suspension for the whale hunts, the Kulluk or Discoverer and support vessels will leave the Camden Bay project area and move to an area mutually agreed upon between Shell and the Alaska Eskimo Whaling Commission. Shell will return to resume activities after the subsistence bowhead whale hunts conclude. At the end of the drilling season, the Kulluk and Discoverer and their Associated Fleets will transit into and

⁴ For the purpose of the permit:

- a. the Kulluk is an "OCS Source" at any time the Kulluk is attached to the seabed at a drill site by at least one anchor; and
- b. a drill site is any location at which Shell is authorized to operate under the permit and for which Shell or the leaseholder has received from BOEMRE an authorization to drill.

through the Chukchi Sea.⁵ Drilling is planned to begin no earlier than July of 2012, and continue seasonally (i.e. July through November each year) through the end of the program.

In the Chukchi Sea, Shell will be allowed the same 120 day drilling season over the period July 1 through November 30 as in the Beaufort Sea. However, because the Chukchi Sea leases are 64 miles (103 km) from shore, drilling will not be stopped for the whaling season.⁶

II. Lead Agency for Consultation

As the agency responsible for managing the mineral resources of the Alaska Outer Continental Shelf, BOEMRE, formerly known as the Minerals Management Service (MMS)⁷, issues leases for federal OCS lands and authorizes the exploration and development of oil and gas reserves on issued leases. In order to conduct those sales, BOEMRE prepares Environmental Impact Statements (EISs) and Environmental Assessments (EAs) as necessary. During the preparation of these materials, BOEMRE examines the environmental consequences and cumulative effects of industrial activities associated with oil and gas development and acts as the lead federal agency for consulting with the U.S. Fish and Wildlife Service (FWS or Service) and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS or Service), collectively referred to as the Services, as required under section 7 of the ESA and section 305(b)(2) of the MSA.

For the oil and gas leasing and exploration activities that BOEMRE oversees in the Beaufort and Chukchi Seas, it initiated and completed programmatic consultations with the Services and received a Biological Opinion (BO) from NMFS on July 17, 2008, and from FWS on September 3, 2009. In addition, as detailed in the attached Appendices, EPA has previously engaged in informal consultation and discussions with the Services concerning the Shell's air permits. BOEMRE has reinitiated formal consultation with the Services to address, among other issues, the designation of polar bear critical habitat, the proposed listing of the ringed and bearded seals, and the addition of the Pacific walrus to the candidate species list. This supplementary evaluation of air emissions is intended to complement the reinitiated consultation.

III. Species Status Changes and Bowhead Whale Study

Since issuance of the last permits, critical habitat for polar bears was designated, two ice seals (bearded and ringed seals) were proposed to be added to the list of threatened species, and the Pacific walrus was added to the list of candidate species.

⁵ Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska, Flaxman Island Blocks 6659, 6610, 6658, Beaufort Sea Lease Sales 195 and 202, May 4, 2011 (Camden Bay EP).

⁶ Public Information Revised Outer Continental Shelf Lease Exploration Plan, Chukchi Sea Alaska, Burger Prospect: Posey Area Blocks 6714, 6762, 6764, 6812, 6912, 6915, May 12, 2011 (Chukchi Sea EP)

⁷ See Footnote 2.

- Polar bear (*Ursus maritimus*) – critical habitat designated
- Ringed seals (*Phoca hispida*) – proposed Threatened
- Bearded seals (*Erignathus barbatus nauticus*), 2 distinct population segments (DPS) – proposed Threatened
 - *Beringia DPS*
 - *Okhotsk DPS* – no known distribution in U.S. waters
- Pacific walrus (*Odobenus rosmarus divergens*) – Candidate

Designated Polar Bear Critical Habitat

On January 6, 2011 (75 FR 76086), the designated critical habitat for polar bears became effective. The designated habitat comprises three different units: sea ice, terrestrial denning, and barrier islands.

The sea ice habitat unit occurs over the continental shelf at depths of 300 meters or less and is used by polar bears for feeding, breeding, denning, and movement. The location of this habitat varies geographically depending on the time of year and weather and oceanographic conditions. During spring and summer, sea ice habitat follows the northward progression of the ice edge as it retreats northward. In fall, sea ice habitat follows the southward progression of the ice edge. Due to the impracticability of mapping sea ice, the habitat unit was established as the area within the United States used by the polar bear, and within that area, the extent of the continental shelf. In some areas the habitat boundary extends to the Exclusive Economic Zone.

Polar bears create maternal dens in snowdrifts. The terrestrial denning habitat unit includes topographic features such as coastal bluffs and river banks that provide denning habitat with suitable microhabitat characteristics including steep, stable slopes with water or relatively level ground below, unobstructed and undisturbed access between den sites and the coast, and the absence of human disturbance or activities that might attract other bears. The designated habitat extends along the northern coast of Alaska, and at varying distances inland, from Barrow to the Canadian Border.

The barrier island habitat unit is used for denning, refuge from human disturbance, and for movement along the coast to access maternal den and optimal feeding habitat. Polar bears use barrier islands as migration corridors and move freely between the islands by swimming or walking on ice or shallow sand bars. Although less dynamic than sea ice barrier islands constantly shift due to erosion and deposition. However, the location of barrier islands generally parallels the mainland coast of Alaska. Designated barrier island habitat includes off-shore islands from the Canadian border westward and southward to Hooper Bay, and includes ice, water, and terrestrial habitat within 1 mile of the mean high tide line of the barrier islands.

The final rule designating polar bear critical habitat identified petroleum hydrocarbons as a source of pollution that could render areas containing identified physical and biological features unsuitable for use by polar bears. The greatest risk to habitat from petroleum hydrocarbons associated with oil and gas exploration and development is from the potential effect of an oil spill or discharge into the marine environment. Combustion

of petroleum hydrocarbons was not specifically identified in the final rule as a pollution threat to polar bear critical habitat.

Although BOEMRE has reinitiated consultation with FWS on the polar bear's designated critical habitat, EPA notes that BOEMRE evaluated this issue as part of a conference with FWS after the proposed rule to designate critical habitat in October 2009. On December 3, 2009, BOEMRE sent to FWS an evaluation that concluded the total effect of proposed drilling activities would not result in the adverse modification of the physical or biological features essential to the conservation of the proposed polar bear critical habitat. The evaluation further explained mitigation measures that would help ensure that no adverse modification occurs. These mitigation measures include limiting ice disturbance to a minimum; development and implementation of a comprehensive oil discharge prevention and contingency plan; and conditions on vessel operations specifying that vessels will use transit routes more than 25 miles offshore, not operate within 0.5 miles (800 m) of polar bears observed on land or sea ice, and follow specific corridors at least 1 mile from barrier islands.

With respect to potential operational impacts apart from air emissions, EPA intends to rely, as appropriate, on the conclusions of BOEMRE as the lead federal agency and its ongoing communications with FWS to ensure ESA compliance. Further information on the polar bear and its critical habitat can be found in the previously issued FWS BOs and Shell's May 2011 Revised Camden Bay Exploration Plan and Environmental Impact Analysis.

Ringed and Bearded Seals Proposed for Listing as Threatened Species

On December 10, 2010, NMFS proposed to list ringed seals (*Phoca hispida*) (75 FR 77476) and two distinct populations (DPS) of the subspecies of the bearded seal (*Erignathus barbatus*) as threatened under the ESA (75 FR 77496). As of the date of this analysis, NMFS has not issued a final decision on either proposal. However, as previously mentioned, BOEMRE is conferring with NMFS to address the proposed listing of the ring and bearded seals and EPA intends to rely on the conclusions of that conference, as appropriate, with respect to potential impacts from Shell's activities apart from air emissions.

Ringed Seals

The ringed seal (*Phoca hispida*) is the smallest of the northern seals, with typical adult body sizes of 1.5 m in length and 70 kg in weight. The average life span of ringed seals is about 15–28 years. As the common name of this species suggests, its coat is characterized by ring-shaped markings. Ringed seals are adapted to remaining in heavily ice-covered areas throughout the fall, winter, and spring by using the stout claws on their fore flippers to maintain breathing holes in the ice.

The seasonality of ice cover strongly influences ringed seal movements, foraging, reproductive behavior, and vulnerability to predation. There are three ecological seasons recognized for ringed seals: "open water or foraging period" when ringed seals forage most intensively; early winter through spring when seals rest primarily in subnivean lairs

on the ice, referred to as the “subnivean period;” and the period between abandonment of the lairs and ice break-up, referred to as the “basking period.”

Bearded Seals

The bearded seal exists as two subspecies, *E.b. nauticus* (Pacific sector) and *E.b. barbatus* (Atlantic sector). Based on its review, NMFS concluded that two DPS of the *E. b. nauticus* species, commonly inhabiting the Pacific sector, are likely to become endangered throughout all or a significant portion of their ranges in the foreseeable future. The two DPS are the Beringia DPS, and the Okhotsk. The Okhotsk DPS are not found in U.S. waters. The Beringia DPS is found throughout the Bering and Chukchi Seas where the shallow continental shelf provides the seals favorable foraging habitat.

As the ice retreats in the spring most adult bearded seals in the Bering Sea are thought to move north through the Bering Strait, where they spend the summer and early fall at the southern edge of the Chukchi and Beaufort Sea pack ice and at the wide, fragmented margin of multi-year ice. As the ice forms again in the fall and winter, most seals move south with the advancing ice edge through Bering Strait and into the Bering Sea where they spend the winter.

As mentioned, Shell’s proposed operations are restricted to the open water season of July through November. The impacts from air pollutants associated with these operations will be largely limited to this same period and are expected to dissipate rapidly when operations cease. During the permitted period of operations, the majority of bearded and ringed seals in the Beaufort and Chukchi Seas are expected to be at the southern edge of the ice pack or on shorefast ice.

Pacific Walrus Added as Candidate Species

On February 10, 2011, the FWS designated the Pacific walrus (*Odobenus rosmarus divergens*) as a candidate species for listing as threatened or endangered (76 FR 7634). As a matter of discretion, EPA is considering potential air emissions impacts to the Pacific walrus given its at-risk status and in case the Pacific walrus is eventually added to the list of threatened or endangered species.

New Evidence of Bowhead Whales Olfactory System

Subsequent to the 2010 permits, NMFS informed Region 10 during the April 11, 2011 discussion that new information on the bowhead whales indicates that bowhead and other non-toothed whales have an olfactory system and a sense of smell that can be used to find aggregations of krill on which they feed. At NOAA’s request, EPA conducted a literature search to see if there exists any additional information that might indicate whether the air emissions from the exploratory drilling could have an impact on the endangered whales. While we did find a study discussing the effects of engine exhaust on orca whales⁸, no information specific to bowhead whales was located.

⁸ Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds, Lachmuth, C.L., Barrett-Lennard, L. G.-B., Steyn, D.Q., Milsom, W.K., Marine Pollution Bulletin, Volume 62, Issue 4, April 2011, at 792-805.

Given this lack of information, the limited extent and duration of any direct exposure of bowhead whales to the air emissions, and the limited extent and duration of any changes to marine chemistry that may be caused by the air emissions, EPA does not believe the emissions would have adverse effects on bowhead olfaction. Accordingly, the new information does not change EPA's earlier determination, concurred with by NMFS, that air emissions are not expected to have measurable adverse effects on bowhead whales.

IV. Potential Impact from Air Emissions

While consultations and conferences between BOEMRE and the Services will address the impacts to critical habitat and proposed and candidate species from the exploratory drilling and associated activities apart from air emissions, EPA provides the following information concerning the effects of our permitted action.

Air Pollutant Emissions

Air pollutant emissions from the drill ships and the associated fleets were considered, along with background air pollution concentrations, to estimate worst-case air pollution concentrations that could occur during the permitted operations. The air quality modeling results for the Discoverer under the Revised Draft permits for the Beaufort and Chukchi Seas are provided in Table 1. Table 2 summarizes the air modeling results for the Kulluk in the Beaufort Sea. Further information on the air quality analysis can be found in Shell's air permit applications, the Statement of Basis accompanying the draft permits, and EPA's Ambient Air Quality Impact Analysis for the Kulluk and Discoverer. The Statement of Basis and Ambient Air Quality Impact Analysis are available on EPA's website at <http://yosemite.epa.gov/R10/airpage.nsf/permits/ocsap/>.

Table 1: Ambient Air Quality Standards and Maximum Ambient Air Pollution Levels Estimated to Result During Shell's Exploratory Drilling Operations – Discoverer

Pollutant	Averaging Time	National Ambient Air Quality Standard (µg/m3)	Maximum Estimated Pollution Levels* (µg/m3)	
			Beaufort Sea	Chukchi Sea
Nitrogen Dioxide (NO2)	1-hour	188	81.6	174
	Annual	100	3.9	5.3
Particulate Matter (PM2.5)	24-hour	35	18.2	23.4
	Annual	15	3.5	2.4
Particulate Matter (PM10)	24-hour	150	63.7	90.5
	1-hour	196	35.0	40.3
	3-hour	1,300	24.4	27.6
	24-hour	365	9.9	13.1

Pollutant	Averaging Time	National Ambient Air Quality Standard (µg/m ³)	Maximum Estimated Pollution Levels* (µg/m ³)	
			Beaufort Sea	Chukchi Sea
Sulfur Dioxide (SO ₂)	Annual	80	3.2	1.8
Carbon Monoxide (CO)	1-hour	40,000	2,235.9	1,520.9
	8-hour	10,000	1,446.8	1,273.7

* Maximum estimated pollution levels are derived by adding the increase in air pollutant emissions expected to result from Shells activities to existing background concentrations of air pollution and regional sources. The worst case emissions scenarios from Shell's operations are used as inputs to air quality models to derive the maximum estimated pollution levels. Note: Shell used a conservative approach to estimate the above concentrations. The maximum levels occur very close to the Discoverer (at the ambient air boundary) and decrease as distance from the Discoverer increases.

Table 2: Ambient Air Quality Standards and Maximum Ambient Air Pollution Levels Estimated to Result During Shell's Exploratory Drilling Operations – Kulluk, Beaufort Sea

Pollutant	Averaging Time	National Ambient Air Quality Standards (NAAQS) (µg/m ³)	Maximum Estimated Pollution Levels* (µg/m ³)
Nitrogen Dioxide (NO ₂)	1-hour	188	151.5
	Annual	100	15.4
Particulate Matter (PM _{2.5})	24-hour	35	34.0
	Annual	15	5.0
PM-10	24-hour	150	73.8
Sulfur Dioxide (SO ₂)	1-hour	196	43.0
	3-hour	1,300	37.9
	24-hour	365	24.8
	Annual	80	4.2
Carbon Monoxide (CO)	1-hour	40,000	3,010
	8-hour	10,000	1,806

* Maximum estimated pollution levels are derived by adding the increase in air pollutant emissions expected to result from Shells activities to existing background concentrations of air pollution and regional sources. The worst case emissions scenarios from Shell's operations are used as inputs to air quality models to derive the maximum estimated pollution levels. Note: Shell used a conservative approach to estimate the above concentrations. The maximum levels also occur very close to the Kulluk (at the ambient air boundary) and decrease and distance from the Kulluk increases.

Current air quality in the project areas attains EPA's National Ambient Air Quality Standards (NAAQS) and this is expected to continue to be the case. EPA's permit would authorize additional emissions of air pollutants from the exploratory drilling and

associated activities. See Tables 1 and 2 above for pollution levels expected to result from these activities when added to current background levels.

To estimate the maximum ambient air pollutant levels resulting from the Discoverer and the Kulluk and their associated fleets, a variety of modeling emissions scenarios were developed including the scenario with the ice management fleet operating upwind of the Discoverer or the Kulluk to break up or redirect any ice if necessary, and the OSR fleet operating downwind of the Discoverer or the Kulluk in the direction which any oil spill would drift. The impact analysis also includes the emissions of the resupply vessel in transit within 25 miles of the Discoverer or the Kulluk.⁹

As noted in Tables 1 and 2, the worst-case air pollutant concentrations analyzed are below the Primary and Secondary NAAQS for those pollutants in both the Beaufort and Chukchi Seas. EPA developed the NAAQS for pollutants considered harmful to human health and the environment. Primary standards set limits to protect human health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, and vegetation. Since the modeling indicates that the NAAQS will be met within 500 meters of the center of the drill rigs, air pollutant impacts are expected to be negligible, localized, short-term, and dissipate rapidly when drilling operations cease. Accordingly, EPA believes the air emissions will not have an adverse effect on the conservation function of sea ice, barrier islands, and denning habitats identified as essential to polar bear recovery. The anticipated emissions from the permit include nitrogen oxides (NO_x), sulfur dioxide (SO₂) and sulfur compounds; EPA is not aware of any toxicity information on these pollutants specific to the polar bear's critical habitat.

For similar reasons, based on a review of the proposed listings for the ice seals and the determination that listing is warranted for the walrus, as well as the scientific literature search EPA previously conducted for listed species, EPA believes the air emissions will also not have adverse effects on the ice seals or walrus.

EPA found no references to literature regarding the potential impacts from air pollutant inhalation or exposure to ambient concentrations of the specific air emissions anticipated from the operation of the Kulluk or Discoverer. Additionally, the FWS' Range-Wide Status Review of the Polar Bear found that the three main groups of contaminants in the Arctic thought to present the greatest potential threat to marine mammals are petroleum hydrocarbons, persistent organic pollutants, and heavy metals.

Diesel-fired combustion units are not expected to release persistent organic pollutants or substantive quantities of heavy metals. EPA concluded that while the combustion of fossil fuels emits petroleum hydrocarbons, the most direct exposure to threatened and

⁹ Section 328(a)(4)(C) of the CAA, 42 U.S.C. § 7627(a)(4)(C), provides that "...emissions from any vessel servicing or associated with an OCS source, including emissions while at the OCS source or en route to or from the OCS source within 25 miles of the OCS source, shall be considered direct emissions from the OCS source."

endangered marine species comes from direct contact and ingestion of oil from acute and chronic oil spills. Therefore, the greater risk to threatened and endangered marine species from oil and gas development in the Arctic are from the potential for increased oil and fuel spills rather than emissions of petroleum hydrocarbons from the combustion of fossil fuels.

Emissions of air pollutants will also be minimized by conditions contained in the draft air permits. These conditions include hourly and seasonal limits on operations, requirements to use ultra-low sulfur diesel, and installation and operation of pollution controls. In addition, as noted above, air emissions in the Revised Draft Permits for the Discoverer have been significantly reduced from the 2010 permits. The Services previously concluded for the 2010 permits that proposed air emissions from the Discoverer's Beaufort and Chukchi Seas drilling activities would have no measurable or adverse effects to species or critical habitat, above those already considered in previous consultations. See Appendices C and Appendix E.

Duration and Extent of Exploratory Drilling

The BOs discussed above anticipate that exploratory drilling activity will be limited to an "open water" period generally described as July through November in the Chukchi Sea and July through October in the Beaufort Sea, although annual variations may occur. If issued, EPA's air permits for both the Beaufort and Chukchi Seas would authorize exploratory drilling for 120 days each year between July 1 and November 30. This authorization is consistent with the presumed open water season in the Chukchi Sea. In the Beaufort Sea, the permits would authorize a longer drilling season (by one month) than the presumed open water season. However, the days of operation under the permits are limited to 120 (4 months) and the actual drilling authorization period will be established by BOEMRE's approval of exploration drilling. Therefore, it is BOEMRE's approval that ultimately limits actual drilling activities in the area. EPA's permits will include conditions that require Shell to comply with any other applicable Federal and state regulations.

Shell's permit applications state that the time necessary to complete a well – which includes drilling a mud-line cellar; drilling the well; and casing, logging, and cementing the well – is estimated to be 30 days. Accordingly, under the 120 days operational period authorized by the permits, Shell could theoretically expect to complete four wells, although the time in transit between drilling locations and climactic conditions may prevent the completion of four wells. The extent of exploratory drilling considered in the BOs discussed above ranged from completion of two to four wells per drilling season. Thus, the maximum extent of exploratory well drilling is generally consistent with the extent of exploratory drilling assumed by the Services in the BOs.

V. Essential Fish Habitat

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with NMFS with respect to any action authorized, funded, or undertaken by the agency that may adversely affect any essential

fish habitat (EFH) identified under the MSA, 16 U.S.C. § 1855(b)(2), and implementing regulations at 50 CFR § 600.920. For activities that may have an adverse effect on EFH, agencies must provide NMFS with a written assessment of those effects unless the agency determines that the action would not adversely affect EFH. 40 C.F.R. § 600.920(e)(1).

BOEMRE is the lead Federal agency for authorizing oil and gas exploration activities on the Alaskan OCS, including the Beaufort Sea and the Chukchi Seas. In accordance with the MSA, BOEMRE consults on EFH at the oil and gas lease sale stage and consulted with NMFS in connection with Lease Sale 193 in the Chukchi Sea. BOEMRE received NMFS' conservation recommendations pursuant to Section 305(b)(4)(A) in a letter dated January 30, 2007. BOEMRE considered these recommendations in making its final determination on Lease Sale 193.

BOEMRE consulted with NMFS in connection with Lease Sales 186, 195, and 202 in the Beaufort Sea. BOEMRE received NMFS' comments on the Draft Environmental Impact Statement for the Lease Sales in a letter dated September 6, 2002. In this letter NMFS stated that no additional EFH consultation was required for the lease sale but the need for additional EFH consultation should be determined as specific projects are proposed.

In August 2009, EFH was designated for three species – saffron cod, Arctic cod, and Opillio crab. To address MSA consultation requirements for the newly designated EFH, BOEMRE is preparing a separate EFH assessment to be delivered to NMFS in the summer of 2011 for Lease Sale 193 in the Chukchi Sea. Any conservation recommendations resulting from that consultation will be addressed in BOEMRE's Final Environmental Impact Statement for Lease Sale 193. The most recent EFH consultation for OCS exploration in Beaufort Sea was conducted concurrently with the preparation and public review of the Arctic Multiple-Sale Draft Environmental Impact Statement. BOEMRE received NMFS' conservation recommendations in a letter dated June 26, 2009.

BOEMRE is currently updating its Environmental Assessment for Shell's Revised Camden Bay Outer Continental Shelf Lease Exploration Plan. This Environmental Assessment will include EFH consultation, as necessary, to address the effects of Shell's proposed exploration drilling project in the Beaufort Sea on EFH.

Based on review and consideration of the information described above, EPA believes that the levels of air pollutant emissions authorized by our permits will have no effect on EFH. Therefore, EPA defers to BOEMRE as the lead agency consulting with the Services on EFH for other related impact from oil and gas exploration in the Chukchi and Beaufort Sea Planning Areas.

VI. Conclusion

EPA has determined that no likely adverse effects on polar bear critical habitat, proposed ice seals, or candidate walrus will occur from air emissions authorized by EPA's CAA permits. EPA has also determined that new information on the potential susceptibility of bowhead whales to air emissions does not warrant reinitiation of previously-completed

consultation. Accordingly, EPA anticipates no additional adverse effects on polar bear critical habitat or the relevant species beyond those considered by BOEMRE and the Services' in completed and ongoing consultation, conference, and coordination efforts addressing these important resources.

LIST OF APPENDICES

- APPENDIX A – Maps of OCS Lease Blocks Authorized by the Draft Permits for the Kulluk in the Beaufort Sea.
- APPENDIX B –EPA’s 2009/2010 ESA Analysis and Letters to the Services regarding Air Permits for Shell in the Chukchi Sea.
 - B1. “Evaluation and Basis of EPA Region 10’s Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Gulf of Mexico Inc. Outer Continental Shelf Air Permit” (Chukchi Sea 2010).
 - B2. Letter from Janis Hastings, EPA R10, to Rosa Meehan, U.S. Fish and Wildlife Service, Anchorage, AK, re: Informal Consultation Obligations, (Chukchi Sea) 9/4/2009.
 - B3. Letter from Janis Hastings, EPA R10, to Deborah Rocque, U.S. Fish and Wildlife Service, Fairbanks, AK, re: Informal Consultation Obligations, (Chukchi Sea) 9/4/2009.
 - B4. Letter from Janis Hastings, EPA R10, to Robert D. Mecum, NOAA, re: Informal Consultation Obligations, (Chukchi Sea) 9/4/2009.
 - B5. Letter from Janis Hastings, EPA R10, to Robert D. Mecum, NOAA, re: Clarification of EPA Determinations Regarding Potential Effects of CAA Permitting Action on Threatened and Endangered Species (Chukchi Sea) 9/24/2009.
- APPENDIX C – Responses from the Services Regarding EPA’s 2009 ESA Analysis Air permits for Shell in the Chukchi Sea.
 - C1. Letter from Deborah Rocque, U.S. Fish and Wildlife Service, Fairbanks, AK, to Janis Hastings, EPA R10, re: Shell Offshore Inc’s Permit Request for Exploratory Drilling in the Chukchi Sea, 9/23/2009.
 - C2. Letter from Robert Mecum, NOAA, to Janis Hastings re: 09/24/2009 letter from the EPA R10 re Air Permit for Shell in the Chukchi Sea, 10/26/2009.
- APPENDIX D – EPA’s 2009/2010 ESA Analysis and Letters to the Services regarding Air Permits for Shell in the Beaufort Sea.
 - D1. “Evaluation and Basis of EPA Region 10’s Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Offshore Inc. Beaufort Sea Exploration Drilling Program Air Permit” (Beaufort Sea 2010).
 - D2. Letter from Janis Hastings, EPA, to Deborah Rocque, Rosa Meehan, USFWS, re: Basis for Evaluating Potential Effects of Air Permitting Action, (Beaufort Sea) 3/1/2010.

D3. Letter from Janis Hastings, EPA, to Robert Mecum, NOAA, re: Basis for Evaluating Potential Effects of Air Permitting Action, (Beaufort Sea) 3/1/2010.

- APPENDIX E. Responses from the Services regarding the EPA's 2010 Analysis re: Beaufort Sea.

E1. Letter from James W. Balsiger, US Dept of Commerce National Oceanic and Atmospheric Administration, Alaska Region, to Janis Hastings, Region 10 EPA, Re: The Potential Effects on Endangered and Threatened Species and Essential Fish Habitat Due to Shell Beaufort Permit, (Beaufort Sea) 3/30/2010.

E2. - Letter from Ted Swem, Endangered Species Branch Chief, to Janis Hastings, EPA, Re: Shell's Offshore Permit Request for Exploratory Drilling in the Beaufort Sea, (Beaufort Sea) 4/5/2010.

- **APPENDIX A – Maps of OCS Lease Blocks Authorized by the Draft Permits for the Kulluk in the Beaufort Sea**

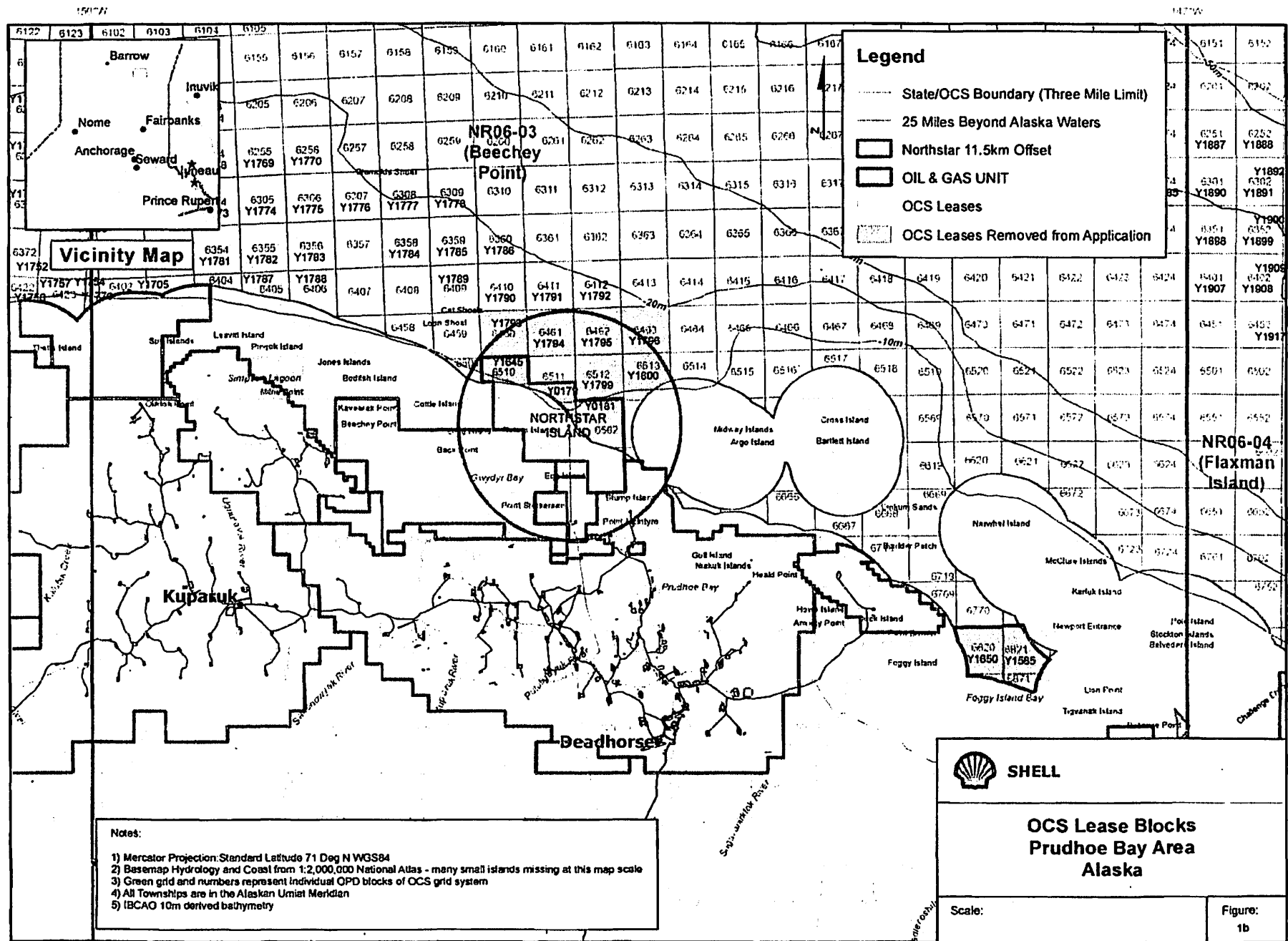
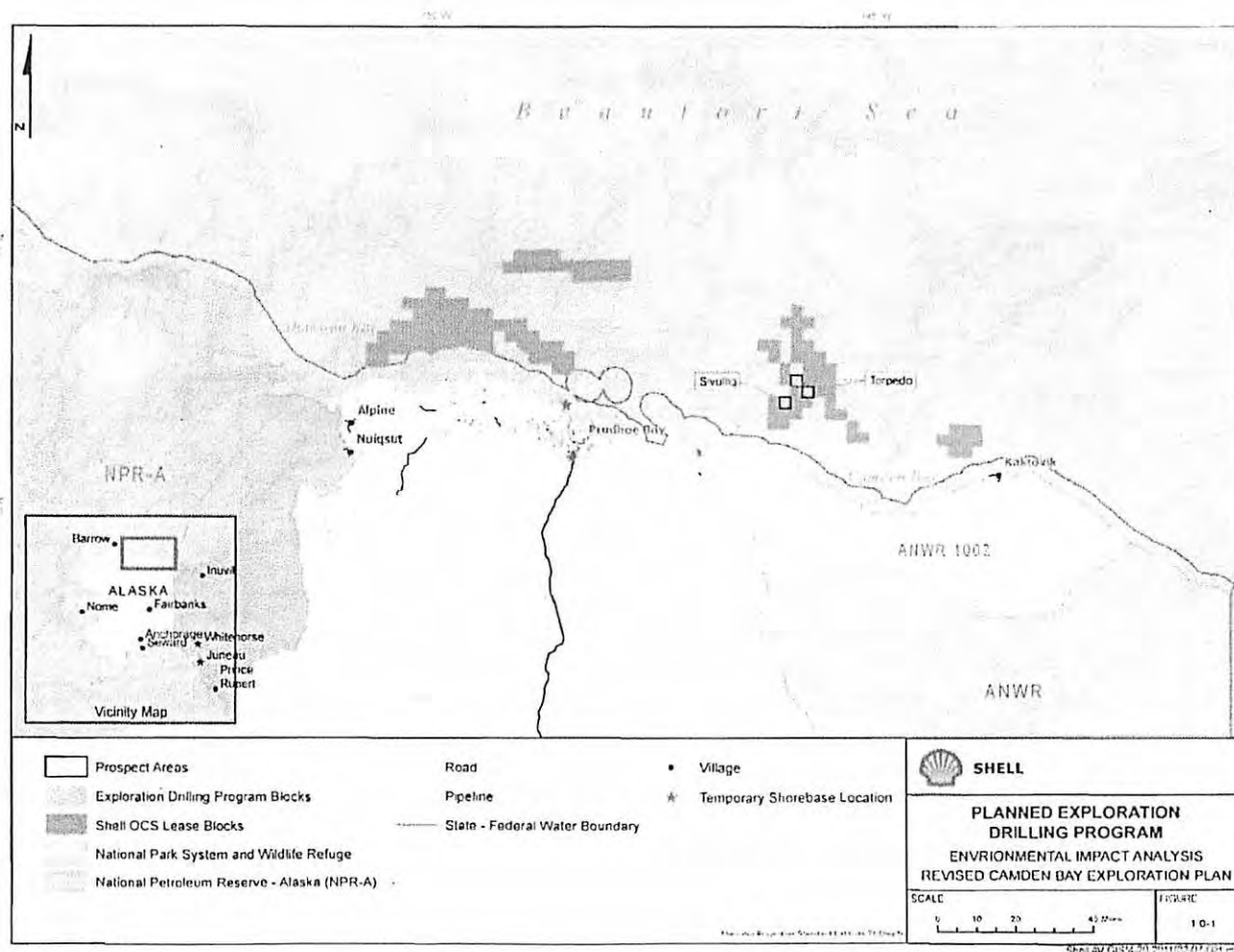


Figure 1.0-1 Camden Bay Exploration Plan Location Map



APPENDIX B - "Evaluation and Basis of EPA Region 10's Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Offshore Inc. Beaufort Sea Exploration Drilling Program Air Permit"

B1. "Evaluation and Basis of EPA Region 10's Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Gulf of Mexico Inc. Outer Continental Shelf Air Permit" (Chukchi Sea 2010).

B2. Letter from Janis Hastings, EPA R10, to Rosa Meehan, U.S. Fish and Wildlife Service, Anchorage, AK, re: Informal Consultation Obligations, (Chukchi Sea) 9/4/2009.

B3. Letter from Janis Hastings, EPA R10, to Deborah Rocque, U.S. Fish and Wildlife Service, Fairbanks, AK, re: Informal Consultation Obligations, (Chukchi Sea) 9/4/2009.

B4. Letter from Janis Hastings, EPA R10, to Robert D. Mecum, NOAA, re: Informal Consultation Obligations, (Chukchi Sea) 9/4/2009.

B5. Letter from Janis Hastings, EPA R10, to Robert D. Mecum, NOAA, re: Clarification of EPA Determinations Regarding Potential Effects of CAA Permitting Action on Threatened and Endangered Species (Chukchi Sea) 9/24/2009.

Evaluation and Basis of EPA Region 10's Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Gulf of Mexico Inc. Outer Continental Shelf Air Permit

I. Background

On November 12, 2008 Shell Gulf of Mexico Inc. (Shell) submitted an application for a preconstruction air permit to EPA Region 10 for the operation of the *Frontier Discoverer* (Discoverer) drillship (source) and an associated fleet in the Chukchi Sea beyond the 25-mile Alaska seaward boundary. The air permit application was subsequently revised and a new air quality analysis submitted to EPA on May 29, 2009 and further supplemented through August 12, 2009.

In its permit application, Shell proposes to operate the Discoverer drillship (a portable major source of air pollutant emissions) at any of its current leases within the Chukchi Sea (Lease Sale 193). An associated fleet consisting of a primary ice management vessel, an anchor-handler/secondary ice management vessel, supply ship, oil spill response (OSR) ship and oil spill workboats will support the drilling operations. The ice management vessels' role is to protect the Discoverer from ice movement and will be deployed upwind of the drillship, since most of the ice is influenced by the wind.

Shell anticipates a drilling season maximum of 168 drilling days (5.5 months), beginning July 1st each year. During this season, it would have the flexibility of drilling one or more wells or parts of wells. It is likely that the environmental conditions (ice) will limit the drilling season to less than these durations. Drilling is planned to begin no earlier than July of 2010 and continue seasonally (i.e. July through December each year) until the resources under Shell's leases are adequately defined.

The Discoverer is a turret-moored drillship equipped with generators for the drilling systems and associated self-powered equipment (such as air compressors, hydraulic pumps, cranes, boilers and other small sources), thrusters for positioning, and an emergency generator for the critical non-drilling loads when the main power supply is not operating. Air pollutant emissions from these combustion sources and the associated fleet were considered, along with background air pollution concentrations, to estimate worst-case air pollution concentrations that could occur from the permitted operations. The air quality screening modeling results are provided in Table 1. Further information on the screening analysis is included in the air pollutant emissions section below and a detailed discussion of the results and associated calculations for both short-term and annual impacts can be found in Shell's air permit application.

If issued, EPA's permit will authorize emissions of air pollutants from the drillship and associated fleet. This document details EPA's account and basis for compliance with its obligations under section 7 of the Endangered Species Act (ESA), 16 U.S.C. §1531 *et seq.*, and section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens

Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1801 *et seq.*, as it relates to EPA's issuance of a Clean Air Act permit to Shell.

Table 1: Ambient Air Quality Standards and Maximum Ambient Air Pollution Levels Estimated to Result From Shell's Exploratory Drilling Operations

Pollutant	Averaging Time	National Ambient Air Quality Standard (µg/m3)	Maximum Estimated Pollution Levels* (µg/m3)
Nitrogen Dioxide (NO2)	Annual	100	24.6
Particulate Matter (PM2.5)	24-hour	35	34.3
	Annual	15	3.7
Particulate Matter (PM10)	24-hour	150	37.7
	Annual	50	5.9
Sulfur Dioxide (SO2)	3-hour	1,300	92.2
	24-hour	365	38.4
	Annual	80	2.1
Carbon Monoxide (CO)	1-hour	40,000	1,440.5
	8-hour	10,000	889.2

* Maximum estimated pollution levels are derived by adding the increase in air pollutant emissions expected to result from Shells activities to existing background concentrations of air pollution. The worst case emissions scenarios from Shells operations are used as input to air quality models to derive the maximum estimated pollution levels.

II. Threatened and Endangered Species and Critical Habitat

The following species are known to occur in the Chukchi Sea Lease Sale 193 Area and are listed as threatened or endangered under the ESA, or are candidate species for listing:

- Spectacled eider (*Somateria fischeri*) - Threatened
- Steller's eider (*Polysticta stelleri*) - Threatened
- Kittlitz's murrelet (*Brachyramphus brevirostris*)- Candidate
- Yellow-billed Loon (*Gavia adamsii*) - Candidate
- Polar bear (*Ursus maritimus*) - Threatened
- Bowhead whale (*Balaena mysticetus*) - Endangered
- Fin whale (*Balaenoptera physalus*) - Endangered
- Humpback whale (*Megaptera novaeangliae*) - Endangered

In addition, the Ledyard Bay Critical Habitat Unit (LBCHU) is a federally recognized critical habitat area to protect spectacled eiders habitat. The LBCHU was designated because of its importance to migrating and molting spectacles eiders, and includes waters of Ledyard Bay within 1-46 mi (1.9-75 km) from shore.

Further information on the species and habitat listed above can be found in the Services previously issued biological opinions described in Section IV below, Shell's May 2009 Exploration Plan, and Shell's accompanying Environmental Impact Analysis (EIA) for its 2010 Exploration Drilling Program.

III. Lead Agency for Consultation

As the agency responsible for managing the mineral resources of the Alaska Outer Continental Shelf, the Minerals Management Service (MMS) leases federal lands for the exploration and development of oil and gas reserves. In order to conduct those sales, MMS prepares EISs and EAs as necessary. During the preparation of these materials, the MMS examines the environmental consequences and cumulative effects of industrial activities associated with oil and gas development and acts as the lead federal agency for consulting with the US Fish and Wildlife Service (FWS or the Service) and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) (collectively referred to as the Services) as required under section 7 of the Endangered Species Act (ESA), 16 U.S.C. § 1531 *et seq.*, and section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1801 *et seq.*

Pursuant to Section 7 of the ESA, the MMS Alaska OCS office consulted with the FWS and NMFS regarding the potential effects of Lease Sale 193 on threatened and endangered species. As part of its consultation, MMS submitted the following biological evaluations to the Services:

- Biological Evaluation of Spectacled Eider, Steller's Eider and Kittlitz's Murrelet for Chukchi Lease Sale 193 (September 2006); and
- Biological Evaluation of the Potential Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on Endangered Bowhead Whales, Fin Whales, and Humpback Whales (March 2006, Supplemented May 2008).

In response to the biological evaluations and in conclusion of the consultations, the Services issued its biological opinions as described in Section IV below.

In addition to the consultations between MMS and the Services, the FWS conducted its own intra-agency consultation for the development of its incidental take regulations (ITR) for Pacific walruses and polar bears during oil and gas exploration in the Chukchi. Its programmatic biological opinion for the ITRs is also discussed in Section IV below.

IV. Summary of Previously Issued Biological Opinions for Exploratory Drilling and Associated Activities in the Chukchi Sea

The Services issued three biological opinions (BOs) concluding consultations regarding impacts from exploratory drilling on threatened and endangered (T&E) species and designated critical habitats. Since these BO's address the same types of exploratory

drilling activities authorized by EPA's air permit, EPA is relying in part on the conclusions drawn in the BO's for its final determination. A summary of the conclusion from each biological opinion is presented below.

U.S. FWS March 27, 2007, Biological Opinion for Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Associated Seismic Surveys and Exploratory Drilling. This document transmits the FWS' BO in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act), on effects to Spectacled Eider, Stellar's Eider, and Ledyard Bay Critical Habitat Unit (LBCHU). At MMS's request, the FWS also evaluated potential effects on the candidate Kittlitz's Murrelet to aid planning in the event it becomes listed during this project's life, but the document does not represent a formal BO for Kittlitz's murrelets.

The BO assesses whether the incremental step of leasing and exploration would be likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat. Activities proposed under the first incremental step are seismic surveys, exploratory drilling, and associated vessel and aircraft traffic. The BO characterizes the activities as temporary, largely confined to the marine environment, and having relatively small impact areas. The assessment of the exploratory drilling is based on MMS estimates that 7-14 test wells would be required to discover and delineate the first commercial field and that drilling operations would range from 30-90 days at each well site (i.e., up to four wells could be drilled by each drill rig in each open water season).

In the incremental step of Lease Sale 193 (leasing and exploration), the FWS concluded that no adverse effects to listed eiders or candidate Kittlitz's murrelets are anticipated from habitat loss, disturbance and displacement, increased predation, increased subsistence hunting, toxics contamination, or oil spills. Adverse effects to listed species are anticipated from collisions, however, it would be limited to the incidental take of a few individual spectacled and Steller's eiders. It's the FWS' biological opinion that the exploration in Lease Sale 193, including drilling and related activities that would be authorized by EPA's air permit, is not likely to jeopardize the continued existence of the spectacled or Steller's eider and is not likely to destroy or adversely modify designated critical habitat. Nor is it likely to pose significant threats for the candidate Kittlitz's Murrelet.

Disturbance and displacement to the species from vessel transits would be minimized by several factors. First, the amount of vessel traffic in the region is limited by the number of drill ships available for use (currently only two). Also, the portion of the LBCHU thought to receive the greatest use by eiders is outside Lease Sale 193 boundaries, which would also serve to reduce impact. Finally, an MMS stipulation restricting vessel traffic in the LBCHU from July 1-November 15 will further minimize disturbance of molting eiders and transiting vessels. The Service also found that while displacement of listed eiders may occur in the small portions of the spring lead system and LBCHU that overlap with the lease sale area, the impact areas would be small, stationary, and occur only once. Impacts from collisions will be minimized by MMS measures that regulate seismic and

exploratory drilling activities and are expected to affect a limited number of Steller's and spectacled eiders.

The FWS' Incidental Take Statement (ITS) concludes that 3 adult spectacled eiders and 1 adult Steller's eider may be incidentally taken through collisions with structures during activities authorized by the BO on the incremental step of leasing and exploration for Lease Sale 193. The ITS includes measures which are non-discretionary, and must be undertaken by the MMS so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(0)(2) to apply. The MMS has a continuing duty to regulate activities covered by this incidental take statement. If the MMS (1) fails to assume and implement the terms and conditions, or (2) fails to require any applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(0)(2) may lapse.

Programmatic Biological Opinion for Polar Bears on Chukchi Sea Incidental Take Regulations, Fairbanks Fish and Wildlife Field Office, June 3, 2008. This document transmits the FWS' programmatic BO in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA), on effects to the polar bear incidental take regulations (ITR). The regulations were promulgated on June 11, 2008 (73 FR 33212) and provide authorization under the Marine Mammal Protection Act of 1972, as amended (MMPA) for the non-lethal, incidental take of small numbers of Pacific walruses and polar bears during oil and gas industry exploration activities in the Chukchi Sea and adjacent western coast of Alaska. The consultation for polar bears on the Chukchi Sea ITR was an intra-Service consultation, which considers effects of Service action (the ITR) on listed species.

The ITR identifies permissible methods of non-lethal taking, measures to ensure the least practicable adverse impact on the species and the availability of these species for subsistence uses, and requirements for monitoring and reporting. The process spelled out in the ITR includes the requirement for the citizens of the United States to request from the FWS annual Letters of Authorization (LOA) to conduct activities under the provisions of the ITR. The FWS finds the total expected takings of walruses and polar bears during industry exploration activities, including the types of activities that would be authorized by EPA's air permit, will have a negligible impact on these species and will not have an unmitigable adverse impact on the availability of these species for subsistence use by Alaska Natives.

Oil and gas activities anticipated and considered in the analysis of the Chukchi Sea ITR include: (1) marine-streamer 3D and 2D seismic surveys; (2) high-resolution site-clearance surveys; (3) offshore exploration drilling; (4) onshore seismic exploration and exploratory drilling; and the associated support activities for the afore-mentioned activities.

Under the operating scenario analyzed in the ITR, drilling operations are expected to range between 30 and 90 days at different well sites and be limited to the open water

season July 1 to November 30. The FWS estimated that as many as three drill ships could be operating in the Chukchi Sea Region in any given year and each drill ship could drill up to four exploratory or delineation wells per season during the specified time frame of the ITR (2008–2012). Each drill ship is likely to be supported by one to two ice management vessels, a barge and tug, one to two helicopter flights per day, and one to two supply ships per week.

Although industry activities may adversely affect a small number of polar bears within the action area, mitigating measures included in the proposed action reduce the potential for exposure to adverse effects through temporal and spatial separation between polar bears and industry activities, and reduce potential adverse effects in cases of unavoidable interactions (e.g., curious bears drawn to the activity) and unintentional consequences of the activities (e.g., oil spills). In addition to these mitigating measures proposed by industry, other project specific mitigating measures may be required through the issuance of an LOA under the ITR. The ITR, while allowing a “small number” of animals to be incidentally taken by harassment, provide a mechanism requiring that mitigating measures are implemented, monitored, and reported annually. Thus the ITR contribute to the collection of additional information that will aid in developing and/or further refining mitigating measures for future Industry activities.

After reviewing the current status of the polar bear; the environmental baseline for the Chukchi Sea Regulations action area; the effects of the proposed Regulations; documented impacts of industry activities on the species; data provided by monitoring programs in the Beaufort Sea (1993–2006) and the Chukchi Sea (1991–1996); and the cumulative effects; it is the FWS’ biological opinion that the Regulations, as proposed, are not likely to jeopardize the continued existence of the polar bear. Critical habitat has not been designated or proposed for the polar bear; therefore none will be destroyed or adversely modified.

National Marine Fisheries Service's (NMFS) revised Biological Opinion for Federal oil and gas leasing and exploration by the Minerals Management Service (MMS) within the Alaskan Beaufort and Chukchi Seas, July 17, 2008. This opinion considers the effects of oil and gas leasing and exploration in the U. S. Beaufort Sea and Chukchi Seas, and authorization of "small take" permits under section 101 (a)(5) of the Marine Mammal Protection Act, as amended on threatened and endangered species under the jurisdiction of NOAA Fisheries, including endangered fin, humpback, and bowhead whales.

For purposes of analyses, NMFS assumes that a maximum of two drilling rigs would operate at any time, with a total of six exploration and six delineation wells expected to be drilled over the 8-year exploration period. Exploration activity (seismic surveys and drilling) will begin with seismic surveying in summer of 2006 and continue through 2013, with delineation wells drilled through 2014. Exploration will result in an increase in marine vessel activity, and depending on location and season, may include ice management vessels, barges, tugs, supply and crew boats, and other vessels. Many offshore activities also include support by helicopter traffic and fixed' wing aircraft.

The greatest concerns associated with the impacts of oil and gas exploration on marine mammals is potential impacts of noise. During OCS oil and gas exploration, human-caused noise is transmitted through the air and through marine waters from a variety of sources including, but not limited to: 2D/3D seismic surveys; pipeline, platform, and related shore-based construction; drilling; ice management vessels and other ships, barge transit; high-resolution seismic surveys; and helicopter and fixed-winged aircraft traffic.

Overall, fin, humpback, or bowhead whales exposed to noise-producing activities such as drilling operations, would most likely experience temporary, non-lethal effects. Some avoidance behavior could persist up to 12-24 hours. Whale response to certain noise sources varies and can be context specific (i.e., feeding versus migrating whales, related to reproductive status and/or sex or age). Depending on the timing, location, and number, exploration activities could potentially produce sufficient noise and disturbance that whales might avoid an area of high value to them and suffer consequences of biological significance. This would be of particular concern if such an area was one used for feeding or resting by large numbers of individuals or females and calves.

However, available information does not indicate that oil-and gas-related activity (or any recent activity) has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of the Western Arctic bowhead whale population. Likewise, available information does not indicate that oil-and gas-related activity (or any recent activity) in the Chukchi and Beaufort has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of humpback and fin whales.

After reviewing the current status of the endangered bowhead, fin and humpback, the environmental baseline for the action area, the proposed action, and the cumulative effects, it is NMFS' biological opinion that individual bowhead whales within the action area may be adversely affected, but that the proposed action is not likely to jeopardize the continued existence of Western Arctic bowhead, North Pacific fin or humpback whales. Furthermore, no critical habitat has been designated for these species and, therefore, none will be affected.

As noted above, this opinion also addresses NMFS' authorization of the incidental and unintentional taking of fin, humpback, and bowhead whales due to certain oil and gas exploration activities. Section 101 (a)(5) of the Marine Mammal Protection Act (MMPA), directs the Secretary of Commerce to allow, upon request by U.S. citizens engaged in a specific activity (other than commercial fishing) in a specified geographical region, the incidental but not intentional taking of small numbers of marine mammals if certain findings are made. Such authorization may be accomplished through issuance of an incidental harassment authorization (IHA).

V. Provisions that Warrant Further Consultation

While the MMS and Services consultations address the impacts to threatened and endangered (T&E) species and critical habitats from the exploratory drilling and

associated activities that would be authorized by the issuance of an EPA air permit, EPA identified two aspects of our proposed air permit we believe warrant further consultation with the Services:

- Whether our air permit limits the duration and extent of exploratory drilling to that anticipated in the biological opinions issued, and
- Whether there is jeopardy to the species from the emissions of air pollutants authorized by our permitting action.

Duration and Extent of Exploratory Drilling

The BO's discussed above anticipate a limited amount of exploratory drilling and a period of drilling activity limited to an "open water" period from July 1 to November 30th each year. If issued, EPA's air permit will be for an unlimited number of years and would authorize drilling for 168 days each year between July 1 and December 31, without limitation on the number of wells drilled during the vessel's life.

Thus the air permit would authorize a longer drilling period and larger number of wells than assessed in the BO's. However, the actual amount of drilling that could occur is limited by the MMS and its approval of any exploration plan (EP) for any year that Shell requests approval. Therefore, EPA believes any inconsistency in the drilling duration and extent in our air permit is addressed by the requirement of MMS to re-initiate consultation with the Services before approving any EP that allows exploration activity outside the scope of the activity already consulted on. As provided in 50 C.F.R. 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if, among other things, the agency action is subsequently modified in a manner that causes an effect to listed or critical habitat not considered in the BO's.

In addition, EPA's permit will include conditions that Shell must adhere to, including being in compliance with other applicable Federal and state regulations. Thus, the drilling activity authorized by EPA's air permit must also be in compliance with the FWS ITRs. The ITRs, specifically 50 CFR 18.118(a)(3), only authorize off shore exploration activities during the open water season defined as the period between July 1 and November 30 and exemption waivers may only be issued on a case-by-case basis.

Air Pollutant Emissions and Affect on Species

Current air quality in the project area attains EPA's National Ambient Air Quality Standards (NAAQS) and is expected to continue to do so. EPA's permit would authorize additional emissions of air pollutants from the exploratory drilling and associated activities and the maximum increase in pollution levels (see Table 1) expected to result from these emissions were calculated for the ambient air boundary considered to be the Discoverer's hull.

To estimate the maximum air pollutant levels from the *Discoverer* and its associated fleet, the modeling emissions scenario was developed with the ice management fleet operating upwind of the *Discoverer* to break up any ice so it will flow around it, and the

OSR fleet operating downwind of the *Discoverer*, the safe and protected side, and the direction in which any oil spill would drift. The impact analysis also includes the emissions of the resupply vessel in transit within 25 miles of the *Discoverer*.

The ice management fleet, OSR fleets and resupply ship in transit are characterized in the air quality impact analysis using an elevated line source (series of adjacent volume sources) at the nearest edge of anticipated activity to the *Discoverer*. This configuration represents a worst-case scenario since, in reality, the ice management fleet will be breaking up ice at and beyond the nearest edge of anticipated ice management activity (e.g., further away from the *Discoverer*). The line source characterization is designed to simulate the effect of mobile sources moving around and emitting plumes which rise and form a layer of emissions above ground (e.g., smearing in space of a plume from a moving ship) which is then advected downwind towards the *Discoverer*. This design simulates the effect of ice management fleet under its highest emitting scenario, which is a continual churning up of one-year ice drifting toward the *Discoverer*.

As noted in Table 1, the worst-case air pollutant concentrations are below the Primary and Secondary NAAQS. EPA developed the NAAQS for pollutants considered harmful to public health and the environment. Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

Shell evaluated the impacts of emissions of air pollutants authorized by our permit on threatened and endangered species in its May 2009 Chukchi Sea Exploration Plan and associated Environmental Impact Analysis and found that emissions of air pollutants from its exploration drilling program would have a negligible impact on listed species.

Emissions of air pollutants will be minimized by conditions (i.e., operational and pollution control technology requirements) in EPA's air permit and pollution levels will be below the secondary NAAQS (generally considered protective of damage to animals, crops, and vegetation). Since the NAAQS will be met at the hull of the ship, potential impacts from air pollutant emissions are expected to be negligible and would be short-term, dissipating rapidly when drilling operations cease.

Summary of literature search and results:

EPA searched the scientific literature for additional information regarding potential impacts of emissions of air pollutants on the T&E species in the Chukchi Sea Lease Sale 193 Area. Searches of the scientific literature were conducted through EPA's Library Services using Science Direct (Elsevier journal database) and the Dialog Environmental Information suite of databases, including: Agricola, Biosis Previews, CAB Abstracts, Energy Science & Technology, General Sciences Abstracts, National Technical Information Services and Waternet. The years searched were 1980 to present using the following key words: air and (ambient or quality); pollut? and (endangered or threatened or polar bear or eider or murrelet or loon or whale).

While we found several articles regarding the effect of contaminants in T&E species, we found no references to literature regarding the potential impacts from air pollutant inhalation or exposure to ambient concentrations of the specific emissions anticipated from the exploratory drilling activities. Additionally the FWS' Range-Wide Status Review of the Polar Bear¹ found that the three main groups of contaminants in the Arctic thought to present the greatest potential threat to marine mammals are petroleum hydrocarbons, persistent organic pollutants, and heavy metals.

While the combustion of fossil fuels emits petroleum hydrocarbons, the status review found that the most direct exposure to T & E marine species comes from direct contact and ingestion of oil from acute and chronic oil spills. Therefore, the greater risk to T& E marine species from increases in Arctic oil and gas development and trans-Arctic shipping are from the potential for increased oil and fuel spills rather than emissions of petroleum hydrocarbons from the combustion of fossil fuels in the vessels.

VI. Essential Fish Habitat:

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with NOAA Fisheries Service (NMFS) with respect to any action authorized, funded, or undertaken by the agency that may adversely affect any essential fish habitat identified under the MSA.

The MMS is the lead Federal agency for authorizing oil and gas exploration activities on the Alaskan outer continental shelf, including the Chukchi Sea. In accordance with the MSA, MMS consulted with NMFS regarding its Lease Sale 193 in the Chukchi Sea, and the associated affects of oil and gas exploration activities. In its January 30, 2007 letter, the NMFS responded to MMS's determination that activities associated with oil and gas exploration may have adverse effects on EFH by offering EFH Conservation Recommendation pursuant to Section 305(b)(4)(A) of the MSA. The MMS considered these recommendations in making it final determination on Lease Sale 193.

Based on review and consideration of the information described above, EPA believes that the levels of air pollutant emissions authorized by our permit are not likely to adversely affect EFH and, therefore, defers to the MMS as the lead agency consulting with the Services on EFH for other related impact from oil and gas exploration in the Chukchi Sea Lease Sale 193.

VII. Conclusion

As discussed in the above referenced BO's, Shell's proposed activities could adversely affect species through disturbance of individuals in marine waters and collisions with vessels. These potential impacts have been assessed in section 7 consultations with MMS and the Services and will be minimized by Shell's implementation of mitigation

¹ Range-Wide Status Review of the Polar Bear, U.S. Fish and Wildlife Service (Scott Schliebe, Thomas Evans, Kurt Johnson, Michael Roy, Susanne Miller, Charles Hamilton, Rosa Meehan, & Sonja Jahrsdoerfer), December 21, 2006.

measures. No additional adverse effects are anticipated to result from activities authorized by the issuance of EPA's CAA permit.

Based on the information and documents discussed above, EPA has determined that the issuance of a CAA permit to Shell for exploratory drilling may affect T & E Species or critical habitat but is not likely to cause additional adverse effects beyond those already considered and addressed by the Services in the prior consultations. This is particularly true since the air permit will include a condition requiring Shell to comply with other federal regulations. As a result, Shell will need to obtain an annual LOA from the FWS in accordance with the ITR allowing for a continuous assessment of impacts to marine mammals based on any new scientific data. Similarly, Shell will need to obtain an Incidental Harassment Authorization from the NMFS for endangered whales in accordance with the MMPA.



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AIR, WASTE AND TOXICS

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Anchorage, Alaska 99503

Dear Ms. Meehan:

This letter is part of our informal consultation with your staff regarding the Clean Air Act permit we anticipate issuing to Shell Offshore Inc. for exploratory drilling in the Chukchi Sea. In accordance with Section 7 of the Endangered Species Act (ESA) and Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), we are transmitting our basis for evaluating the potential effects of our air permitting action on the Threatened and Endangered (T&E) species and their designated critical habitat and request your concurrence with our conclusions.

Shell Gulf of Mexico Inc. (Shell) applied for a preconstruction air permit from the U.S. Environmental Protection Agency (EPA), Region 10, for the operation of the *Frontier Discoverer* drillship and an associated fleet in the Chukchi Sea beyond the 25 mile Alaska seaward boundary. The air permit application is made under the Outer Continental Shelf (OCS) permitting rules (40 CFR Part 55). The air permit would authorize air emissions from offshore exploratory drilling operations authorized by the U.S. Minerals Management Service (MMS).

As you are aware, the MMS is the lead consultation agency for the activities associated with oil and gas exploration on the OCS and has previously consulted with the Services regarding the impacts of oil and gas exploration activities in the Chukchi Sea. In addition, the intra-service consultation conducted for the issuance of Incidental Take Regulations (ITR) under the Marine Mammal Protection Act (MMPA) for the Chukchi Sea included an assessment of these activities. While the U.S. National Marine Fishers Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) have issued biological opinions and concluded consultations regarding the activities authorized by the issuance of EPA's air permit, we reviewed those actions and determined that the concluded consultations would benefit from additional analysis regarding the potential effects of the air pollutant emissions authorized by our permitting action on T&E species. Accordingly, we are providing the enclosed analysis of those effects.

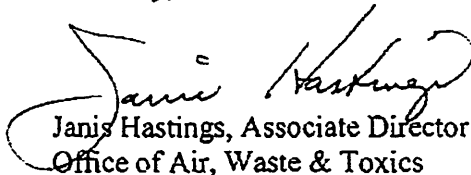
If issued, EPA's air permit will authorize emissions from drilling for 168 days per year for an unlimited number of years. The annual drilling period begins July 1 and extends through December 31. This time period is beyond the "open water" period for which MMS previously consulted with the Services (MMS anticipated activity during an open water season ending November 30). However, as indicated in the attached analysis, we believe this inconsistency

between the active drilling period that would be authorized by our permit and the "open water" period for which MMS previously consulted is addressed by the permit conditions requiring Shell to comply with other Federal regulations, including FWS's ITR (73 FR 33212). The ITR, specifically 50 CFR § 18.118(a)(3), authorize off shore exploration activities only during the open water season defined as the period between July 1 and November 30. While exemption waivers may be issued on a case-by-case basis, it is our understanding that MMS could not approve exploration plans with drilling activity beyond November 30, without re-initiating consultation with the Services, since this activity would be beyond the scope of activity previously analyzed in the concluded consultations.

Enclosed, please find our evaluation and basis for our conclusion that the issuance of a Clean Air Act permit to Shell for exploratory drilling may affect T & E Species or critical habitat but is not likely to cause additional adverse effects beyond those already considered and addressed by the Services in the prior consultations. We have also included our conclusion that the issuance of the air permit will have no additional effects on essential fish habitat.

We are requesting that the Services concur in writing with our conclusions. We will contact you if any additional ESA and MSA-related issues arise during our permitting process. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or call Dan Brown at 503-326-6832.

Sincerely,


Janis Hastings, Associate Director
Office of Air, Waste & Toxics

Enclosure

cc: Ted Swern,
Endangered Species Branch Chief
UFWS, Fairbanks Field Office

Craig Perham
Wildlife Biologist
UFWS Marine Mammals Management, Anchorage

Brad Smith
Field Office Supervisor
NMFS, Anchorage Field Office

Matthew Eagleton
EFH Coordinator
NMFS, Anchorage Field Office



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

SEP 04 2009

OFFICE OF
AIR, WASTE AND TOXICS

Deborah Rocque
Supervisor
US Fish and Wildlife Service
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

Dear Ms. Rocque:

This letter is part of our informal consultation with your staff regarding the Clean Air Act permit we anticipate issuing to Shell Offshore Inc. for exploratory drilling in the Chukchi Sea. In accordance with Section 7 of the Endangered Species Act (ESA) and Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), we are transmitting our basis for evaluating the potential effects of our air permitting action on the Threatened and Endangered (T&E) species and their designated critical habitat and request your concurrence with our conclusions.

Shell Gulf of Mexico Inc. (Shell) applied for a preconstruction air permit from the U.S. Environmental Protection Agency (EPA), Region 10, for the operation of the *Frontier Discoverer* drillship and an associated fleet in the Chukchi Sea beyond the 25 mile Alaska seaward boundary. The air permit application is made under the Outer Continental Shelf (OCS) permitting rules (40 CFR Part 55). The air permit would authorize air emissions from offshore exploratory drilling operations authorized by the U.S. Minerals Management Service (MMS).

As you are aware, the MMS is the lead consultation agency for the activities associated with oil and gas exploration on the OCS and has previously consulted with the Services regarding the impacts of oil and gas exploration activities in the Chukchi Sea. In addition, the intra-service consultation conducted for the issuance of Incidental Take Regulations (ITR) under the Marine Mammal Protection Act (MMPA) for the Chukchi Sea included an assessment of these activities. While the U.S. National Marine Fishery Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) have issued biological opinions and concluded consultations regarding the activities authorized by the issuance of EPA's air permit, we reviewed those actions and determined that the concluded consultations would benefit from additional analysis regarding the potential effects of the air pollutant emissions authorized by our permitting action on T&E species. Accordingly, we are providing the enclosed analysis of those effects.

If issued, EPA's air permit will authorize emissions from drilling for 168 days per year for an unlimited number of years. The annual drilling period begins July 1 and extends through December 31. This time period is beyond the "open water" period for which MMS previously consulted with the Services (MMS anticipated activity during an open water season ending November 30). However, as indicated in the attached analysis, we believe this inconsistency between the active drilling period that would be authorized by our permit and the "open water"

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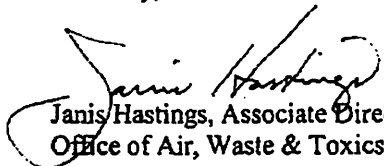
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period for which MMS previously consulted is addressed by the permit conditions requiring Shell to comply with other Federal regulations, including FWS's ITR (73 FR 33212). The ITR, specifically 50 CFR § 18.118(a)(3), authorize off shore exploration activities only during the open water season defined as the period between July 1 and November 30. While exemption waivers may be issued on a case-by-case basis, it is our understanding that MMS could not approve exploration plans with drilling activity beyond November 30, without re-initiating consultation with the Services, since this activity would be beyond the scope of activity previously analyzed in the concluded consultations.

Enclosed, please find our evaluation and basis for our conclusion that the issuance of a Clean Air Act permit to Shell for exploratory drilling may affect T & E Species or critical habitat but is not likely to cause additional adverse effects beyond those already considered and addressed by the Services in the prior consultations. We have also included our conclusion that the issuance of the air permit will have no additional effects on essential fish habitat.

We are requesting that the Services concur in writing with our conclusions. We will contact you if any additional ESA and MSA-related issues arise during our permitting process. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or call Dan Brown at 503-326-6832.

Sincerely,


Janis Hastings, Associate Director
Office of Air, Waste & Toxics

Enclosure

cc: Ted Swern,
Endangered Species Branch Chief
UFWS, Fairbanks Field Office

Craig Perham
Wildlife Biologist
UFWS Marine Mammals Management, Anchorage

Brad Smith
Field Office Supervisor
NMFS, Anchorage Field Office

Matthew Eagleton
EFH Coordinator
NMFS, Anchorage Field Office



E001552



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

SEP 04 2009

OFFICE OF
AIR, WASTE AND TOXICS

Robert D. Mecum
Acting Regional Administrator
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

Dear Mr. Mecum:

This letter is part of our informal consultation with your staff regarding the Clean Air Act permit we anticipate issuing to Shell Offshore Inc. for exploratory drilling in the Chukchi Sea. In accordance with Section 7 of the Endangered Species Act (ESA) and Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), we are transmitting our basis for evaluating the potential effects of our air permitting action on the Threatened and Endangered (T&E) species and their designated critical habitat and request your concurrence with our conclusions.

Shell Gulf of Mexico Inc. (Shell) applied for a preconstruction air permit from the U.S. Environmental Protection Agency (EPA), Region 10, for the operation of the *Frontier Discoverer* drillship and an associated fleet in the Chukchi Sea beyond the 25 mile Alaska seaward boundary. The air permit application is made under the Outer Continental Shelf (OCS) permitting rules (40 CFR Part 55). The air permit would authorize air emissions from offshore exploratory drilling operations authorized by the U.S. Minerals Management Service (MMS).

As you are aware, the MMS is the lead consultation agency for the activities associated with oil and gas exploration on the OCS and has previously consulted with the Services regarding the impacts of oil and gas exploration activities in the Chukchi Sea. In addition, the intra-service consultation conducted for the issuance of Incidental Take Regulations (ITR) under the Marine Mammal Protection Act (MMPA) for the Chukchi Sea included an assessment of these activities. While the U.S. National Marine Fishers Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) have issued biological opinions and concluded consultations regarding the activities authorized by the issuance of EPA's air permit, we reviewed those actions and determined that the concluded consultations would benefit from additional analysis regarding the potential effects of the air pollutant emissions authorized by our permitting action on T&E species. Accordingly, we are providing the enclosed analysis of those effects.

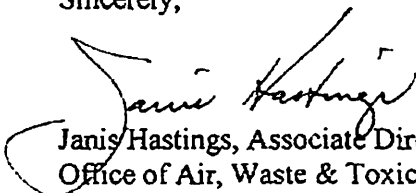
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between the active drilling period that would be authorized by our permit and the "open water" period for which MMS previously consulted is addressed by the permit conditions requiring Shell to comply with other Federal regulations, including FWS's ITR (73 FR 33212). The ITR, specifically 50 CFR § 18.118(a)(3), authorize off shore exploration activities only during the open water season defined as the period between July 1 and November 30. While exemption waivers may be issued on a case-by-case basis, it is our understanding that MMS could not approve exploration plans with drilling activity beyond November 30, without re-initiating consultation with the Services, since this activity would be beyond the scope of activity previously analyzed in the concluded consultations.

Enclosed, please find our evaluation and basis for our conclusion that the issuance of a Clean Air Act permit to Shell for exploratory drilling may affect T & E Species or critical habitat but is not likely to cause additional adverse effects beyond those already considered and addressed by the Services in the prior consultations. We have also included our conclusion that the issuance of the air permit will have no additional effects on essential fish habitat.

We are requesting that the Services concur in writing with our conclusions. We will contact you if any additional ESA and MSA-related issues arise during our permitting process. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or call Dan Brown at 503-326-6832.

Sincerely,



Janis Hastings, Associate Director
Office of Air, Waste & Toxics

Enclosure

cc: Ted Swem,
Endangered Species Branch Chief
UFWS, Fairbanks Field Office

Craig Perham
Wildlife Biologist
UFWS Marine Mammals Management, Anchorage

Brad Smith
Field Office Supervisor
NMFS, Anchorage Field Office

Matthew Eagleton
EFH Coordinator
NMFS, Anchorage Field Office



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10**

1200 Sixth Avenue, Suite 900
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SEP 24 2009

OFFICE OF
AIR, WASTE AND TOXICS

Robert D. Mecum
Acting Regional Administrator
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

Dear Mr. Mecum:

The purpose of this letter is to clarify the US Environmental Protection Agency's (EPA) determinations regarding the potential effects of our Clean Air Act (CAA) permitting action on threatened and endangered (T&E) species within your jurisdiction. Based on the best available data, EPA has determined that issuing a CAA Permit to Shell Gulf of Mexico Inc. (Shell) for exploratory drilling in the Chukchi Sea has no effect on the listed bowhead, fin and humpback whales, beyond those already addressed by the National Marine Fisheries Service (NMFS) in prior consultation under section 7 of the Endangered Species Act.

On September 4, 2009, we sent you our evaluation and basis for our conclusion that the issuance of a CAA permit to Shell for exploratory drilling may affect T & E species or critical habitat but is not likely to cause additional adverse effects beyond those already considered and addressed by the NMFS. Subsequent to the letter, EPA and NMFS staff further discussed the context of EPA's finding, and EPA concluded further clarification is warranted.

As noted in our September 4, 2009, letter and attachment, the Minerals Management Service (MMS) is the lead consultation agency for activities associated with oil and gas exploration on the outer continental shelf. Accordingly, MMS consulted with NMFS regarding the potential impacts to T&E species from the types of oil and gas exploration activities that will be authorized by EPA's CAA Permit. NMFS concluded this consultation on July 17, 2008, issuing its revised Biological Opinion (BO) for Federal oil and gas leasing and exploration by the Minerals Management Service within the Alaskan Beaufort and Chukchi Seas (BO).

The NMFS BO concluded that individual bowhead whales within the action area may be adversely affected, but the proposed actions are not likely to jeopardize the continued existence of Western Arctic bowhead, North Pacific fin or humpback whales. Since EPA relied on this BO as part of its assessment of potential impacts from its CAA permitting action, we stated our findings in the context of the BO (i.e., that EPA's action would not result in any additional effects not already considered in the context of the section 7 consultation with the lead agency). EPA's analysis also included an assessment of two factors unique to EPA's action:

- Whether our air permit limits the duration and extent of exploratory drilling to that anticipated in the biological opinions issued, and

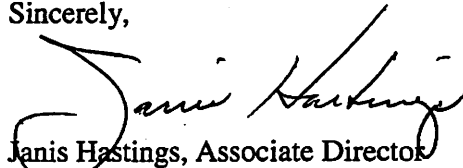
- Whether there are effects on the species from the emissions of air pollutants authorized by our permitting action.

We found no effects to T&E species from these two factors since limits on the duration and extent of exploratory drilling exist outside the CAA permit and, based on best available data, there is no effect to species from these air pollutants.

In conclusion, the intent of our September 4, 2009, letter was to summarize all of the information we relied upon in our analysis, including previous MMS consultations and NMFS' BO, and to specifically request NMFS' view regarding our determination that the additional factors we considered have no effect on T&E species.

I hope you find this additional clarification helpful and would appreciate receiving your view in writing regarding our conclusions within 30 days. If you need any additional information please call me at 206-553-1582 or Dan Brown at 503-326-6832.

Sincerely,



Janis Hastings, Associate Director
Office of Air, Waste and Toxics

Enclosure

cc: Brad Smith, NMFS
Field Office Supervisor
Anchorage Field Office

APPENDIX C - "Evaluation and Basis of EPA Region 10's Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Gulf of Mexico Inc. Outer Continental Shelf Air Permit," (Chukchi Sea)

C1. Letter from Deborah Rocque, U.S. Fish and Wildlife Service, Fairbanks, AK, to Janis Hastings, EPA R10, re: Shell Offshore Inc's Permit Request for Exploratory Drilling in the Chukchi Sea, 9/23/2009.

C2. Letter from Robert Mecum, NOAA, to Janis Hastings re: 09/24/2009 letter from the EPA R10 re Air Permit for Shell in the Chukchi Sea, 10/26/2009.



United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701
September 23, 2009



Ms. Janis Hastings
Associate Director of Air, Waste and Toxics
United States Environmental Protection Agency
Region 10, 1200 Sixth Avenue,
Seattle, WA 98101

Re: Shell Offshore Inc's Permit
Request for Exploratory Drilling in
the Chukchi Sea

Dear Ms. Hastings:

Thank you for your letter requesting a section 7 consultation pursuant to the Endangered Species Act of 1973, as amended (ESA) on EPA's proposed issuance of a Clean Air Act permit to Shell Offshore Inc (Shell) for exploratory drilling in the Chukchi Sea.

We understand Shell proposes to conduct oil and gas exploratory activities in the Chukchi Sea and has requested a Clean Air Act (CAA) permit from the EPA. The permit would authorize air emissions from the Frontier Discoverer drillship and its associated fleet on the Outer Continental Shelf (OCS) the Chukchi Sea beyond the 25 mile Alaska seaward boundary. The fleet will consist of an ice breaker, secondary ice management vessel, supply ship, oil spill response ship, and small oil spill workboats, and possibly a supply ship. Drilling operations would commence on or after July 1, 2010.

The Chukchi Sea is within the range of the spectacled eider (*Somateria fischeri*), the Alaska-breeding Steller's eider (*Polysticta stelleri*), and the polar bear (*Ursus maritimus*), which are listed as threatened under the ESA. In addition, two candidate species are also found in the Chukchi Sea, Kittlitz's murrelet (*Brachyramphus brevirostris*), and the yellow-billed loon (*Gavia adamsii*).

Oil and gas exploration projects in the Chukchi Sea are authorized and regulated by the Minerals Management Service (MMS). The type of activity proposed by Shell, that would be authorized by EPA, has been reviewed under ESA as part of the Service's section 7 consultation with MMS on oil and gas activities in the Beaufort and Chukchi Sea Program Areas (USFWS 2009), and an intra-service consultation on the issuance of the Chukchi Sea Incidental Take Regulations (Chukchi Sea ITRs) under the Marine Mammal Protection Act (MMPA) (USFWS 2008).

Therefore, at EPA's request, we have reviewed proposed issuance of the CCA permit to evaluate if the activities to be permitted would result in impacts to listed species that were

not considered in the previous section 7 consultations and resulting Biological Opinions (BOs). Potential additional impacts considered by EPA could result from the length of the CAA permit, and emissions of air pollutants.

CAA Permit Duration

EPA's CAA will limit permitted activities to July 1 - December 31 for an unlimited number of years. However, the Chukchi Sea ITRs and their resulting Letters of Authorization (LOAs) issued under the MMPA only authorize exploratory drilling activities in the Chukchi Sea between July 1 and November 30 each year until the ITRs expire in 2013.

As the proposed exploratory activities may adversely affect polar bears and we understand Shell has requested an LOA under the Chukchi Sea ITRs, which when issued, will only allow activities between July 1 and November 30, 2010. As the EPA has stated they will require Shell to adhere to, and remain in compliance with other applicable state and Federal regulations, including the Chukchi Sea ITRs, the discrepancy between the length of EPA's permit and the ITR period is moot.

Subsequent activities such as exploratory drilling operations in subsequent years, or after November 30, would require additional authorization under the MMPA, which would also trigger additional section 7 consultation. Therefore, there is no increment of impact that would occur or remain unevaluated as a result of the duration of EPA's CAA permit.

Air Pollutant Emissions

The proposed CAA permit would authorize emissions of air pollutants from exploratory drilling and associated vessel activities. EPA estimated the maximum air pollutant levels that may result from these activities, and the worst-case scenario air pollutant concentrations are all below the primary and secondary National Ambient Air Quality Standards.

The Service considered the potential toxicological effects of the emissions of the exploratory drilling operation on listed and candidate species. The anticipated chemical emissions detailed in the permit include nitrogen oxides (NO_x), sulfur dioxide (SO₂), and sulfur compounds. We are not aware of any specific NO_x, SO₂ or sulfur compound toxicity information for polar bears or listed and candidate avian species.

We also compared the list of anticipated emissions to the anthropogenic contaminants considered a factor affecting the continued existence of the polar bear (Schliebe et al. 2006, Range Wide Status Review of the Polar Bear; page 152-175). None of the anticipated emissions were among the types of contaminants discussed in that report that are known to bioaccumulate or pose toxic effects to polar bears (petroleum hydrocarbons, persistent organic pollutants, mercury, and some other metals). We conclude that the types of limited emissions authorized in this permit are not likely to have the potential to bioaccumulate or have toxic effects on polar bears or listed eiders or candidate species.

In conclusion, adverse effects to listed and candidate species, above those considered in previous BOs, are not anticipated to result from EPA's issuance of this CAA permit to Shell. Therefore, section 7 consultation on the issuance of this permit is concluded informally by this letter.

Sincerely,

A handwritten signature in black ink, appearing to read "F. J. Rocque" followed by "Acting".

Deborah Rocque
Fairbanks Field Office Supervisor

Literature Cited

Schliebe, S., T.J. Evans, K. Johnson, M. Roy, S. Miller, C. Hamilton, R. Meehan, and S. Jahrsdoerfer. 2006. Status assessment in response to a petition to list polar bears as a threatened species under the U.S. Endangered Species Act. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska. 262pp.

USFWS. 2008. Final Biological Opinion for Chukchi Sea Polar Bear Incidental Take Regulations. June 2008. 74pp.

USFWS. 2009. Final Biological Opinion for Beaufort and Chukchi Sea Program Area lease sales and associated seismic surveys and exploratory drilling. Consultation with MMS – Alaska OCS Region. Fairbanks Field Office. 168pp.



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

October 26, 2009

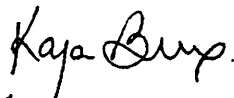
Janis Hastings
Associate Director
Office of Air, Waste, and Toxics
United States Environmental Protection Agency
Region 10
1200 Sixth Avenue, suite 900
Seattle, Washington 98101-3140

Dear Ms. Hastings:

We have received your letter of September 24, 2009 concerning the potential effects on endangered and threatened species due to authorization of a Clean Air Act permit to Shell Gulf of Mexico, Inc. for an exploratory drilling activity in the U.S. Beaufort Sea, to be conducted in 2010. The Environmental Protection Agency has determined this action would not affect endangered bowhead, fin, and humpback whales. We concur with this determination. While our agency is concerned with the air quality of the arctic, and particularly within the habitat of these endangered whales, it does not appear that the type or concentrations of air emissions associated with this activity would have a measurable effect on these species.

Please direct any questions to Mr. Brad Smith at (907) 271-3023.

Sincerely,


For **Robert D. Mecum**
Acting Director, Alaska Region



E001583

APPENDIX D - Letter from Janis Hastings, EPA R10, to Rosa Meehan, U.S. Fish and Wildlife Service, Anchorage, AK, re: Informal Consultation Att.: Evaluation and Basis of EPA R10's Determination Regarding Consultation Obligations, 9/4/2009

D1. "Evaluation and Basis of EPA Region 10's Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Offshore Inc. Beaufort Sea Exploration Drilling Program Air Permit" (Beaufort Sea 2010).

D2. Letter from Janis Hastings, EPA, to Deborah Rocque, Rosa Meehan, USFWS, re: Basis for Evaluating Potential Effects of Air Permitting Action, (Beaufort Sea) 3/1/2010.

D3. Letter from Janis Hastings, EPA, to Robert Mecum, NOAA, re: Basis for Evaluating Potential Effects of Air Permitting Action, (Beaufort Sea) 3/1/2010.

Evaluation and Basis of EPA Region 10's Determination Regarding Consultation Obligations under Section 7 of the Endangered Species Act and Section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Shell Offshore Inc. Beaufort Sea Exploration Drilling Program Air Permit

I. Background

On January 18, 2010 Shell Offshore Inc. (Shell) submitted a revised application for a preconstruction air permit to EPA Region 10 for the *Frontier Discoverer* (Discoverer) Beaufort Sea Exploration Drilling Program. In its permit application, Shell proposes to operate the Discoverer drillship (a portable major source of air pollutant emissions) and associated fleet within and beyond 25 miles of the Alaska seaward boundary at any of its current leases within the Beaufort Sea. The associated fleet, consisting of a primary icebreaker, anchor-handler/secondary icebreaker, supply ship, oil spill response (OSR) ship, oil spill workboats and mud barge/tug, will support the drilling operations. The primary icebreaker's role is to protect the Discoverer from ice movement and will be deployed upwind of the drillship, since most of the ice is influenced by the wind.

Shell anticipates a drilling season maximum of 168 drilling days (5.5 months), beginning July 1st each year. During this season, it would have the flexibility of drilling one or more wells or parts of wells. It is likely that the environmental conditions (ice) will limit the drilling season to less than these durations. Drilling is planned to begin no earlier than July of 2010 and continue seasonally (i.e. July through December each year) until the resources under Shell's leases are adequately defined.

The Discoverer is a turret-moored drillship equipped with generators for the drilling systems and associated self-powered equipment (such as air compressors, hydraulic pumps, cranes, boilers and other small sources), thrusters for positioning, and an emergency generator for the critical non-drilling loads when the main power supply is not operating. Air pollutant emissions from these combustion sources and the associated fleet were considered, along with background air pollution concentrations, to estimate worst-case air pollution concentrations that could occur from the permitted operations. The air quality modeling results are provided in Table 1. Further information on the air quality analysis is included in the air pollutant emissions section below and a detailed discussion of the results and associated calculations for both short-term and annual impacts can be found in Shell's air permit application.

If issued, EPA's permit will authorize emissions of air pollutants from the drillship and associated fleet. This document details EPA's account and basis for compliance with its obligations under section 7 of the Endangered Species Act (ESA), 16 U.S.C. §1531 *et seq.*, and section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1801 *et seq.*, as it relates to EPA's issuance of a Clean Air Act permit to Shell.

Table 1: Ambient Air Quality Standards and Maximum Ambient Air Pollution Levels Estimated to Result From Shell's Exploratory Drilling Operations

Pollutant	Averaging Time	National Ambient Air Quality Standard (µg/m3)	Maximum Estimated Pollution Levels* (µg/m3)
Nitrogen Dioxide (NO2)	Annual	100	31
Particulate Matter (PM2.5)	24-hour	35	27.2
	Annual	15	3.1
Particulate Matter (PM10)	24-hour	150	75.8
	Annual	50	8.6
Sulfur Dioxide (SO2)	3-hour	1,300	66.6
	24-hour	365	16.2
	Annual	80	6.0
Carbon Monoxide (CO)	1-hour	40,000	2977.1
	8-hour	10,000	1527.5

* Maximum estimated pollution levels are derived by adding the increase in air pollutant emissions expected to result from Shells activities to existing background concentrations of air pollution and regional sources. The worst case emissions scenarios from Shells operations are used as input to air quality models to derive the maximum estimated pollution levels.

II. Lead Agency for Consultation

As the agency responsible for managing the mineral resources of the Alaska Outer Continental Shelf, the Minerals Management Service (MMS) leases federal lands for the exploration and development of oil and gas reserves. In order to conduct those sales, MMS prepares Environmental Impact Statements (EISs) and Environmental Assessments (EAs) as necessary. During the preparation of these materials, the MMS examines the environmental consequences and cumulative effects of industrial activities associated with oil and gas development and acts as the lead federal agency for consulting with the US Fish and Wildlife Service (FWS or the Service) and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) (collectively referred to as the Services) as required under section 7 of the Endangered Species Act (ESA), 16 U.S.C. § 1531 *et seq.*, and section 305(b)(2) (essential fish habitat, i.e., EFH) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1801 *et seq.*

The MMS and the Services have been working together to ensure that consultations for oil and gas activities in the Chukchi and Beaufort seas are as current, thorough, and accurate as possible. The most recently concluded consultation results are summarized below and documented in the September 3, 2009, FWS Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling; and the July 17, 2008, NMFS revised Biological Opinion for Federal oil and gas leasing and exploration by the MMS within the Alaskan Beaufort and

Chukchi Seas. EPA is substantively relying on these consultations to meet its obligations under the ESA and MSA.

III. Threatened and Endangered Species and Critical Habitat

The following species are known to occur in the Beaufort and Chukchi seas and are listed as threatened or endangered under the ESA, or are candidate species for listing:

- Polar bear (*Ursus maritimus*) - Threatened
- Spectacled eider (*Somateria fischeri*) - Threatened
- Steller's eider (*Polysticta stelleri*) - Threatened
- Kittlitz's murrelet (*Brachyramphus brevirostris*) - Candidate
- Yellow-billed Loon (*Gavia adamsii*) - Candidate
- Bowhead whale (*Balaena mysticetus*) - Endangered
- Fin whale (*Balaenoptera physalus*) - Endangered
- Humpback whale (*Megaptera novaeangliae*) - Endangered

The Ledyard Bay Critical Habitat Unit (LBCHU) is a federally recognized critical habitat area to protect spectacled eiders habitat in the Chukchi Sea area. The LBCHU was designated because of its importance to migrating and molting spectacles eiders, and includes waters of Ledyard Bay within 1-46 mi (1.9-75 km) from shore. In addition, the FWS proposed critical habitat for the polar bear on October 29, 2009 (74 FR 56058) identifying three different units: sea ice, terrestrial denning and barrier island habitats. The polar bear critical habitat is expected to be finalized by June 30, 2010, just before the start of the 2010 drilling that would be authorized by this permit.

Proposed Polar Bear Critical Habitat

October 29, 2009, the FWS proposed polar bear critical habitat units including sea ice, terrestrial denning, and barrier islands (74 FR 56058). While the September 3, 2009 Biological Opinion discussed below does not specifically address the proposed polar bear critical habitat, it does generally describe the environmental baseline of sea ice, terrestrial denning and barrier island habitats and the effects of exploratory drilling activities on these habitats. The MMS further evaluated the potential effects of Shell's proposed exploration drilling activities, including drilling and related activities that would be authorized by EPA's air permit, on the proposed habitat units in both the Beaufort and Chukchi seas. The MMS concluded that the total effect of proposed drilling activities would not result in the adverse modification of the physical or biological features essential to the conservation of polar bear critical habitats. On December 3, 2009, MMS sent its evaluation and conclusion to FWS noting that further conference under the ESA was not required for exploratory drilling activities in both the Chukchi and Beaufort seas. EPA intends to rely on the conclusions of MMS and its ongoing communications with FWS to ensure ESA compliance upon issuance of a final critical habitat determination.

Further information on the species and habitat listed above can be found in the Services previously issued biological opinion described in Section IV below and Shell's June 2009 Camden Bay Exploration Plan and Environmental Impact Analysis.

IV. Summary of Recently Issued Biological Opinions for Exploratory Drilling and Associated Activities in the Beaufort and Chukchi Seas

The Services have issued several biological opinions (BOs) concluding consultations regarding impacts from exploratory drilling on threatened and endangered (T&E) species and designated critical habitats in both the Beaufort and Chukchi seas. Since these BOs address the same types of exploratory drilling activities authorized by EPA's air permit, EPA is relying in part on the conclusions drawn in the BOs for its final determination. A summary of the most recent BOs and conclusions regarding impacts from exploratory drilling in the Beaufort and Chukchi seas is presented below.

U.S. FWS September 3, 2009, Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling. The document transmits FWS's BO in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA), on effects to listed spectacled eiders (*Somateria fischeri*), Alaska-breeding Steller's eiders (*Polysticta stelleri*), polar bears (*Ursus maritimus*), the Ledyard Bay Critical Habitat Unit (LBCHU), and the candidate species yellow-billed loons (*Gavia adamsii*) and Kittlitz's murrelets (*Brachyramphus brevirostris*).

The action agency for this consultation and lead agency for all consultation with the Services for the development of oil, gas, and other resources on the United States outer continental shelf (OCS), is the MMS. MMS and the Service have been working to ensure that section 7 consultations for oil and gas activities in these Program Areas are as current as possible. The development of the September 3, 2009 BO considered the results of previous consultations; subsequent changes in the status of polar bear, yellow-billed loon, Steller's eiders and the environmental baseline; the MMS Assessment of the Potential Effects of Oil and Gas Leasing Activities in the Beaufort Sea and Chukchi Sea Planning Areas, MMS July 2009; the MMS Draft Environmental Impact Statement for the Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221, MMS 2008; published literature, agency and consultant biological surveys and reports; and personal communication with species experts in the Service and the U.S. Geological Survey (USGS). The September 3, 2009 BO replaces the previously issued BOs for Lease Sales 193, 186, 195, and 202.

The BO provides a thorough and comprehensive analysis of potential impacts to listed species and critical habitat from potential oil and gas leasing, exploration, and development in the Beaufort and Chukchi Sea Program Areas (the Action). The Program Areas include the Beaufort and Chukchi seas including areas MMS has previously made available for leasing (i.e., Lease Sales BF, 71, 87, 97, 109, 124, 144, 170, 186, 195, 202, and 193) and proposed additional lease sales (Chukchi Sea 212 and 221 and Beaufort Sea 209 and 217).

The BO evaluates the potential direct and indirect effects of the Action, as well as cumulative effects and effects of interrelated and interdependent activities, when added to and evaluated within the context of the environmental baseline, to provide an aggregative analysis of impacts to listed species and critical habitat.

The BO assesses whether the incremental step of leasing and exploration would be likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat. Activities proposed under the first incremental step are seismic surveys, exploratory drilling, and associated vessel and aircraft traffic. The BO characterizes the activities as temporary, largely confined to the marine environment, and having relatively small impact areas.

The assessment of the exploratory drilling is based on MMS estimates that two mobile drill rigs or vessels would operate in the arctic OCS during any drilling season. The drill ships could be used to drill prospects in water depths of 20 m or more, and these operations would be supported by icebreakers and supply boats. All drilling activities would use helicopters to fly crew and lighter supplies to the offshore facilities. Up to four wells could be drilled each season with drilling operations ranging from 30-90 days at each well site. A maximum of 36 well are anticipated in the Beaufort Sea.

Although the ESA does not require consultation for candidate species, by mutual agreement with MMS, the BO evaluated the potential impacts to Kittlitz's murrelets and yellow-billed loons, in anticipation of possible future listing.

As noted below, after considering these aggregate effects on the species and LBCHU, it is the Service's biological opinion that this incremental step, including drilling and related activities that would be authorized by EPA's air permit, is not likely to jeopardize the continued existence of any of these species, nor will it destroy or adversely modify critical habitat.

Listed Eiders and Candidate Species - Activities that may result from the first incremental step are likely to adversely affect listed eiders and candidate species. However the impacts are limited to at most the death of a very low number of individuals through collisions (<1 Steller's eider and 12 spectacled eiders over a total of 12 years), and possibly although very unlikely the death of a few individuals in the event a small spill contacts these birds. Therefore, Service concludes this potential level of take, considered in aggregate with and in the context of the status of the species, environmental baseline, and cumulative effects, is not likely to jeopardize the continued existence of listed Steller's and spectacled eiders and the candidate species yellow-billed loons and Kittlitz's murrelets by reducing appreciably the likelihood of survival and recovery of these species.

Polar Bears – Activities that may result from the first incremental step are anticipated to result in levels of impacts similar to those resulting from activities previously authorized under the Beaufort and Chukchi Sea Incidental Take Regulations (ITRs), 71 FR 43926 (August 2, 2006) and 73 FR 33212 (June 11, 2008), respectively. The FWS concluded these activities, when tempered by mitigation measures described in the ITRs, would likely pose negligible and non-jeopardy level threats to polar bears. The FWS estimates that up to 5 polar bears may be observed by each seismic operation and an estimated 22 polar bears may be observed by each exploratory drilling operation over a year. Polar bear responses

observed previously during similar operations were limited to watching or changing their direction of travel. FWS anticipates that any future drilling operations would result in similar levels polar bear response. Therefore, given the low numbers of operations, and the small proportion of the listed population that may encounter them, coupled with the short-term, minor behavioral responses of polar bears to these activities, the Service concludes the incremental step of seismic surveys and exploratory drilling will not jeopardize the continued existence of polar bears by reducing appreciably the likelihood of survival and recovery of the species.

Ledyard Bay Critical Habitat Unit - Impacts to the LBCHU from activities authorized in the first incremental step are anticipated to have only minor, short-term impacts, and will not significantly impact any of the primary constituent elements of critical habitat. The critical habitat unit will still provide the conservation function for which it was designated, namely to provide a rich source of benthic invertebrates and aquatic flora and fauna in waters of an appropriate depth to support molting spectacled eiders. Therefore, the Service concludes this increment of the Action will not alter the primary constituent elements to an extent that appreciably reduces the conservation value of critical habitat for spectacled eiders.

The BO includes the FWS' Incidental Take Statement (ITS) and provides a total estimate of 12 spectacled eiders and less than 1 Steller's eiders will be taken through collisions over 12 years of exploration. The ITS includes measures which are non-discretionary, and must be undertaken by the MMS so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The MMS has a continuing duty to regulate activities covered by this incidental take statement. If the MMS (1) fails to assume and implement the terms and conditions, or (2) fails to require any applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse.

The BO does not provide for incidental take of polar bear. All activities that may take polar bears are subject to prohibitions of the MMPA. Incidental take of small numbers of marine mammals, including polar bears, can be authorized under the MMPA through the issuance of incidental take regulations (ITRs). On August 2, 2006 ITRs were issued for the Beaufort Sea (71 FR 43925). These ITRs assessed seismic surveys, exploratory drilling, development, and production activities in the Beaufort Sea and adjacent North Slope. Letters of Authorization (LOAs) issued under these regulations can authorize the non-lethal, incidental, unintentional take of small numbers of polar bears and Pacific walrus during year-round oil and gas industry exploration, development, and production operations in the Beaufort Sea and adjacent northern coast of Alaska until August 2, 2011. Seismic surveys and exploratory drilling activities in both the Chukchi and Beaufort seas are currently included and authorized under the Beaufort Sea and Chukchi Sea ITRs. Entities (e.g., Industry) seeking authorization for particular projects under these ITRs may annually apply for a Letter of Authorization (LOA) from the Service's Marine Mammals Management (MMM) Office to conduct these activities.

National Marine Fisheries Service's (NMFS) revised Biological Opinion for Federal oil and gas leasing and exploration by the Minerals Management Service (MMS) within the Alaskan Beaufort and Chukchi Seas, July 17, 2008. This opinion considers the effects of oil and gas leasing and exploration in the U. S. Beaufort and Chukchi seas, and authorization of "small take" permits under section 101 (a)(5) of the Marine Mammal Protection Act, as amended on threatened and endangered species under the jurisdiction of NOAA Fisheries, including endangered fin, humpback, and bowhead whales.

For purposes of analyses, NMFS assumes that a maximum of two drilling rigs would operate at any time, with a total of six exploration and six delineation wells expected to be drilled over the 8-year exploration period. Exploration activity (seismic surveys and drilling) will begin with seismic surveying in summer of 2006 and continue through 2013, with delineation wells drilled through 2014. Exploration will result in an increase in marine vessel activity, and depending on location and season, may include icebreakers, barges, tugs, supply and crew boats, and other vessels. Many offshore activities also include support by helicopter traffic and fixed' wing aircraft.

The greatest concerns associated with the impacts of oil and gas exploration on marine mammals is potential impacts of noise. During OCS oil and gas exploration, human-caused noise is transmitted through the air and through marine waters from a variety of sources including, but not limited to: 2D/3D seismic surveys; pipeline, platform, and related shore-based construction; drilling; icebreakers and other ships, barge transit; high-resolution seismic surveys; and helicopter and fixed-winged aircraft traffic.

Overall, fin, humpback, or bowhead whales exposed to noise-producing activities such as drilling operations, would most likely experience temporary, non-lethal effects. Some avoidance behavior could persist up to 12-24 hours. Whale response to certain noise sources varies and can be context specific (i.e., feeding versus migrating whales, related to reproductive status and/or sex or age). Depending on the timing, location, and number, exploration activities could potentially produce sufficient noise and disturbance that whales might avoid an area of high value to them and suffer consequences of biological significance. This would be of particular concern if such an area was one used for feeding or resting by large numbers of individuals or females and calves.

However, available information does not indicate that oil-and gas-related activity (or any recent activity) has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of the Western Arctic bowhead whale population. Likewise, available information does not indicate that oil-and gas-related activity (or any recent activity) in the Chukchi and Beaufort has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of humpback and fin whales.

After reviewing the current status of the endangered bowhead, fin and humpback, the environmental baseline for the action area, the proposed action, and the cumulative effects, it is NMFS' biological opinion that individual bowhead whales within the action area may be adversely affected, but that the proposed action is not likely to jeopardize the

continued existence of Western Arctic bowhead, North Pacific fin or humpback whales. Furthermore, no critical habitat has been designated for these species and, therefore, none will be affected.

As noted above, this opinion also addresses NMFS' authorization of the incidental and unintentional taking of fin, humpback, and bowhead whales due to certain oil and gas exploration activities. Section 101 (a)(5) of the Marine Mammal Protection Act (MMPA), directs the Secretary of Commerce to allow, upon request by U.S. citizens engaged in a specific activity (other than commercial fishing) in a specified geographical region, the incidental but not intentional taking of small numbers of marine mammals if certain findings are made. Such authorization may be accomplished through issuance of an incidental harassment authorization (IHA).

V. Provisions that Warrant Further Analysis

While the MMS and Services consultations address the impacts to threatened and endangered (T&E) species and critical habitats from the exploratory drilling and associated activities that would be authorized by the issuance of an EPA air permit, EPA identified two aspects of our proposed air permit we believe warrant further consideration.

- Whether our air permit limits the duration and extent of exploratory drilling to that anticipated in the biological opinions issued, and
- Whether there are effects on the species from the emissions of air pollutants authorized by our permitting action.

Duration and Extent of Exploratory Drilling

The BOs discussed above anticipate a limited amount of exploratory drilling and a period of drilling activity limited to an "open water" period from July 1 to November 30th each year. If issued, EPA's air permit will be for an unlimited number of years and would authorize drilling for 168 days each year between July 1 and December 31, without limitation on the number of wells drilled during the vessel's life.

Thus the air permit would authorize a longer drilling period and larger number of wells than assessed in the BOs. However, the actual amount of drilling that could occur is limited by the MMS and its approval of any exploration plan (EP) for any year that Shell requests approval. Therefore, it is MMS' approval that ultimately limits actual drilling activities in the area and EPA believes any inconsistency in the drilling duration and extent in our air permit is addressed by the requirement of MMS to re-initiate consultation with the Services before approving any EP that allows exploration activity outside the scope of the activity already consulted on. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if, among other things, the agency action is subsequently modified in a manner that causes an effect to listed or critical habitat not considered in the BOs.

In addition, EPA's permit will include conditions that Shell must adhere to, including being in compliance with other applicable Federal and state regulations. Thus, the drilling activity authorized by EPA's air permit must also be in compliance with the FWS ITRs. The ITRs, specifically 50 CFR 18.118(a)(3), only authorize off shore exploration activities during the open water season defined as the period between July 1 and November 30 and exemption waivers may only be issued on a case-by-case basis.

Air Pollutant Emissions

Current air quality in the project area attains EPA's National Ambient Air Quality Standards (NAAQS) and is expected to continue to do so. EPA's permit would authorize additional emissions of air pollutants from the exploratory drilling and associated activities and the maximum increase in pollution levels (see Table 1) expected to result from these emissions were calculated for the ambient air boundary considered to be the *Discoverer's* hull.

To estimate the maximum air pollutant levels from the *Discoverer* and its associated fleet, the modeling emissions scenario was developed with the ice management fleet operating upwind of the *Discoverer* to break up any ice so it will flow around it, and the OSR fleet operating downwind of the *Discoverer*, the safe and protected side, and the direction in which any oil spill would drift. The impact analysis also includes the emissions of the resupply vessel in transit within 25 miles of the *Discoverer*.

The ice management fleet, OSR fleets and resupply ship in transit are characterized in the air quality impact analysis using an elevated line source (series of adjacent volume sources) at the nearest edge of anticipated activity to the *Discoverer*. This configuration represents a worst-case scenario since, in reality, the ice management fleet will be breaking up ice at and beyond the nearest edge of anticipated ice management activity (e.g., further away from the *Discoverer*). The line source characterization is designed to simulate the effect of mobile sources moving around and emitting plumes which rise and form a layer of emissions above ground (e.g., smearing in space of a plume from a moving ship) which is then advected downwind towards the *Discoverer*. This design simulates the effect of ice management fleet under its highest emitting scenario, which is a continual churning up of one-year ice drifting toward the *Discoverer*.

As noted in Table 1, the worst-case air pollutant concentrations analyzed are below the Primary and Secondary NAAQS for those pollutants. EPA developed the NAAQS for pollutants considered harmful to public health and the environment. Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. Since the NAAQS will be met at the hull of the ship, issues regarding air pollutant emissions are expected to be negligible and would be short-term, dissipating rapidly when drilling operations cease.

EPA searched the scientific literature for additional information regarding potential impacts of emissions of air pollutants on the T&E species in the Chukchi and Beaufort seas. Searches of the scientific literature were conducted through EPA's Library Services using Science Direct (Elsevier journal database) and the Dialog Environmental Information suite of databases, including: Agricola, Biosis Previews, CAB Abstracts, Energy Science & Technology, General Sciences Abstracts, National Technical Information Services and Waternet. The years searched were 1980 to present using the following key words: air and (ambient or quality); pollut? and (endangered or threatened or polar bear or eider or murrelet or loon or whale).

While we found several articles regarding the effect of contaminants in T&E species, we found no references to literature regarding the potential impacts from air pollutant inhalation or exposure to ambient concentrations of the specific emissions anticipated from the exploratory drilling activities. These findings were consistent with the FWS' Range-Wide Status Review of the Polar Bear¹ and MMS's conclusions in its October 2009 Environmental Assessment for Shell's Camden Bay Exploration Plan.

Further, emissions of air pollutants will be minimized by conditions (i.e., operational and pollution control technology requirements) in EPA's air permit. The proposed emissions from the Beaufort drilling activities are similar to those from the Shell's proposed drilling activities in the Chukchi Sea for which the Services concluded would have no measurable or adverse effects to species or critical habitat, above those already considered in previous consultations².

VI. Essential Fish Habitat:

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with NOAA Fisheries Service (NMFS) with respect to any action authorized, funded, or undertaken by the agency that may adversely affect any essential fish habitat identified under the MSA.

The MMS is the lead Federal agency for authorizing oil and gas exploration activities on the Alaskan outer continental shelf, including the Beaufort Sea. In accordance with the MSA, the MMS consults on essential fish habitat at the oil and gas lease sale stage. The most recent EFH consultation for OCS exploration activities in the Beaufort Sea was conducted concurrently with the preparation and public review of the Arctic Multiple-Sale (i.e., lease sales 209, 212, 217 and 221) Draft Environmental Impact Statement (DEIS). The MMS and NMFS consulted regarding the associated affects of oil and gas exploration activities presented in the DEIS and on June 26, 2009, NMFS documented

¹ Range-Wide Status Review of the Polar Bear, U.S. Fish and Wildlife Service (Scott Schliebe, Thomas Evans, Kurt Johnson, Michael Roy, Susanne Miller, Charles Hamilton, Rosa Meehan, & Sonja Jahrsdoerfer), December 21, 2006.

² Letters to Janis Hastings, EPA from Robert Mecum, NMFS and Deborah Rocque FWS dated September 23, 2009 and October 26, 2009, respectively.

the consultation and included EFH Conservation Recommendations pursuant to Section 305(b)(4)(A) of the MSA.

Based on review and consideration of the information described above, EPA believes that the levels of air pollutant emissions authorized by our permit have no effect on EFH beyond those already addressed by the NMFS in prior consultations with MMS. Therefore, EPA defers to the MMS as the lead agency consulting with the Services on EFH for other related impact from oil and gas exploration in the Chukchi and Beaufort Sea Planning Areas.

VII. Conclusion

As discussed in the above referenced BOs, Shell's proposed activities could adversely affect species through disturbance of individuals in marine waters and collisions with vessels. These potential impacts have been assessed in ESA and MSA consultations between MMS and the Services and will be minimized by Shell's implementation of mitigation measures. No additional adverse effects are anticipated to result from activities authorized by the issuance of EPA's CAA permit.

This is particularly true since the air permit will include a condition requiring Shell to comply with other federal regulations. As a result, Shell will need to obtain an annual LOA from the FWS in accordance with the ITR allowing for a continuous assessment of impacts to marine mammals based on any new scientific data. Similarly, Shell will need to obtain an Incidental Harassment Authorization from the NMFS for endangered whales in accordance with the MMPA.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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MAR 01 2010

OFFICE OF
AIR, WASTE AND TOXICS

Deborah Rocque, Supervisor
US Fish and Wildlife Service
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

Rosa Meehan, Supervisor
US Fish and Wildlife Service
Marine Mammals Management
1011 East Tudor Road, MS 341
Anchorage, Alaska 99503

Dear Ms. Rocque and Ms. Meehan:

This letter is part of our informal discussions with your staff regarding the Clean Air Act (CAA) permit we anticipate issuing to Shell Offshore Inc (Shell) for exploratory drilling in the Beaufort Sea. In accordance with Section 7 of the Endangered Species Act (ESA), we are transmitting our basis for evaluating the potential effects of our air permitting action on threatened and endangered (T&E) species and their designated critical habitat and request your concurrence with our conclusions.

As you know, we recently completed informal consultations with you for issuing a CAA permit to Shell for its exploratory drilling activities in the Chukchi Sea. We appreciated your cooperation and timely responses in the consultation on the air permit for Shell's Chukchi activities. Shell's planned activities and permit application for the Beaufort Sea are almost identical to those in the Chukchi Sea. Likewise, the anticipated air pollution emissions from the two projects are similar and we have drawn the same conclusions for the Beaufort drilling activities as we did for the Chukchi drilling activities. You will recall that the Fish and Wildlife Service's (FWS) September 23, 2009 letter to EPA concluded that types of limited emissions authorized by the Chukchi permit are not likely to have the potential to bioaccumulate or have toxic effects on listed or candidate species and that adverse effects to listed and candidate species, above those considered in the previous biological opinions, are not anticipated to result from EPA's issuance of the air permit to Shell.

Shell's Beaufort application is for a preconstruction air permit from EPA Region 10 for the operation of the *Frontier Discoverer* drillship and an associated fleet in the Beaufort Sea within and beyond the 25-mile Alaska seaward boundary. The air permit application is made under the Outer Continental Shelf (OCS) permitting rules (40 CFR Part 55). The air permit would authorize air emissions from offshore exploratory drilling operations authorized by the U.S. Minerals Management Service (MMS). Shell hopes to begin exploratory drilling activities in the Beaufort Sea as early as July 2010.

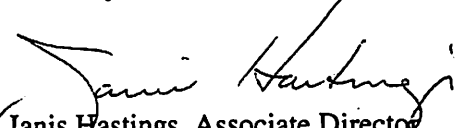
As you are aware, the MMS is the lead consultation agency for the activities associated with oil and gas exploration on the OCS and has previously consulted with the FWS regarding the impacts of oil and gas exploration activities in the Chukchi and Beaufort seas. The FWS' September 3, 2009 biological opinion concluded that the proposed activities are not likely to jeopardize the continued existence of the listed eiders and candidate yellow-billed loon and Kittlitz's murrelets and will not jeopardize the continued existence of the polar bear. On December 3, 2009, MMS also submitted its evaluation and conclusion to FWS that the total effect of proposed drilling activities would not result in the adverse modification of the physical or biological features essential to the conservation of proposed polar bear critical habitats. In addition to relying upon those conclusions of MMS and FWS, we analyzed two additional factors:

- Whether our air permit limits the duration and extent of exploratory drilling to that anticipated in the biological opinions issued, and
- Whether there are effects on the species from the emissions of air pollutants authorized by our permitting action.

Enclosed please find our evaluation of these factors and basis for our conclusion that the issuance of a CAA permit to Shell for exploratory drilling in the Beaufort Sea has no effects on listed and candidate species and proposed polar bear critical habitat units, beyond those already addressed by the FWS in prior consultations.

We are requesting that the Services concur in writing with our conclusions. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or Dan Brown at 503-326-6832.

Sincerely,


Janis Hastings, Associate Director
Office of Air and Waste Management

Enclosure

cc: Ted Swem,
Endangered Species Branch Chief
UFWS, Fairbanks Field Office

Craig Perham,
Wildlife Biologist
UFWS, Marine Mammals Management, Anchorage



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10**

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MAR 01 2010

OFFICE OF
AIR, WASTE AND TOXICS

Robert D. Mecum, Acting Regional Administrator
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, AK 99802-1668

Dear Mr. Mecum:

This letter is part of our informal discussions with your staff regarding the Clean Air Act (CAA) permit we anticipate issuing to Shell Offshore Inc. for exploratory drilling in the Beaufort Sea. In accordance with Section 7 of the Endangered Species Act (ESA) and Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), we are transmitting our basis for evaluating the potential effects of our air permitting action on threatened and endangered (T&E) species and their designated critical habitat and Essential Fish Habitat and request your concurrence with our conclusions.

As you know, we recently completed informal consultation with you for issuing a CAA permit to Shell for its exploratory drilling activities in the Chukchi Sea. We appreciated your cooperation and timely responses in the consultation on the air permit for Shell's Chukchi activities. Shell's planned activities and permit application for the Beaufort Sea are almost identical to those in the Chukchi Sea. Likewise, the anticipated air pollution emissions from the two projects are similar and we have drawn the same conclusions for the Beaufort drilling activities as we did for the Chukchi drilling activities. You will recall that your October 26, 2009 letter to us concurred that the type and concentrations of the air emissions associated with the drilling activity would not have a measurable effect on these species.

Shell's Beaufort Offshore Inc. (Shell) application is for a preconstruction air permit from EPA Region 10 for the operation of the *Frontier Discoverer* drillship and an associated fleet in the Beaufort Sea within and beyond the 25-mile Alaska seaward boundary. The air permit application is made under the Outer Continental Shelf (OCS) permitting rules (40 CFR Part 55). The air permit would authorize air emissions from offshore exploratory drilling operations authorized by the U.S. Minerals Management Service (MMS). Shell hopes to begin exploratory drilling activities in the Beaufort Sea as early as July 2010.

As you are aware, the MMS is the lead consultation agency for the activities associated with oil and gas exploration on the OCS and has previously consulted with the National Marine Fisheries Service (NMFS) regarding the impacts of oil and gas exploration activities in the Chukchi and Beaufort seas. The NMFS's July 17, 2008 revised biological opinion concluded that the proposed activities may adversely affect individual endangered bowhead, fin and

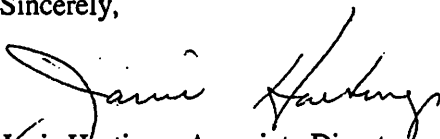
humpback whales, but that the proposed action is not likely to jeopardize the continued existence of these species. In addition to relying upon those conclusions of MMS and NMFS, we analyzed two additional factors:

- Whether our air permit limits the duration and extent of exploratory drilling to that anticipated in the biological opinions issued, and
- Whether there are effects on the species from the emissions of air pollutants authorized by our permitting action.

Enclosed please find our evaluation of these factors and basis for our conclusion that the issuance of a CAA permit to Shell for exploratory drilling in the Beaufort Sea has no effect on the listed bowhead, fin and humpback whales, beyond those already addressed by the NMFS in prior consultations. We have also included our conclusion that the issuance of the air permit will have no effects on essential fish habitat, beyond those already addressed by the NMFS in prior consultations.

We are requesting that the Services concur in writing with our conclusions. If you need any additional information while conducting your review and concurrence, please call me at 206-553-1582 or Dan Brown at 503-326-6832.

Sincerely,



Janis Hastings, Associate Director
Office of Air and Waste Management

Enclosure

cc: Brad Smith,
Field Office Supervisor
NMFS, Anchorage Office

Matthew Eagleton,
EFH Coordinator
NMFS, Anchorage Field Office

APPENDIX E - Letter from Janis Hastings, EPA R10, to Deborah Rocque, U.S. Fish and Wildlife Service, Fairbanks, AK, re: Informal Consultation Att.: Evaluation and Basis of EPA R10's Determination Regarding Consultation Obligations, 9/4/2009

E1. Letter from James W. Balsiger, US Dept of Commerce National Oceanic and Atmospheric Administration, Alaska Region, to Janis Hastings, Region 10 EPA, Re: The Potential Effects on Endangered and Threatened Species and Essential Fish Habitat Due to Shell Beaufort Permit, (Beaufort Sea) 3/30/2010.

E2. - Letter from Ted Swem, Endangered Species Branch Chief, to Janis Hastings, EPA, Re: Shell's Offshore Permit Request for Exploratory Drilling in the Beaufort Sea, (Beaufort Sea) 4/5/2010.



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
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March 30, 2010

Janis Hastings
Associate Director
Office of Air, Waste, and Toxics
United States Environmental Protection Agency
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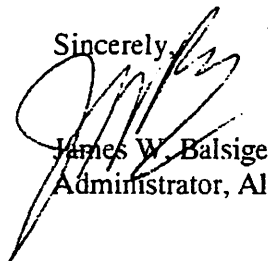
Dear Ms. Hastings:

The National Marine Fisheries Service (NMFS) has reviewed received your letter of March 1, 2010 concerning the potential effects on endangered and threatened species and Essential Fish Habitat (EFH) due to authorization of a Clean Air Act permit to Shell Gulf of Mexico, Inc. for an exploratory drilling activity in the U.S. Beaufort Sea, to be conducted in 2010. The Environmental Protection Agency (EPA) has determined this action would not affect endangered bowhead, fin, and humpback whales. We concur with this determination. While our agency is concerned with the air quality of the Arctic, and particularly within the habitat of these endangered whales, it does not appear that the type or concentrations of air emissions associated with this activity would have a measurable effect on these species.

In addition, the EPA has determined that the proposed action will not adversely affect EFH and has asked NMFS to concur with this determination. The trigger for EFH consultation is a federal action agency's determination that an action may adversely affect EFH. If a federal action agency determines that an action will not adversely affect EFH, no consultation is required. Based on the information in your letter and informal discussions with staff, NMFS concurs with your determination.

Please direct any questions regarding endangered or threatened species to Mr. Brad Smith at (907) 271-3023 or brad.smith@noaa.gov and questions concerning EFH to Ms. Jeanne Hanson at (907) 271-3029 or jeanne.hanson@noaa.gov.

Sincerely,



James W. Balsiger
Administrator, Alaska Region





United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

April 5, 2010



Ms. Janis Hastings
Associate Director of Air, Waste and Toxics
United States Environmental Protection Agency
Region 10, 1200 Sixth Avenue,
Seattle, WA 98101

Re: Shell Offshore Inc's Permit
Request for Exploratory Drilling in
the Beaufort Sea

Dear Ms. Hastings:

Thank you for your letter requesting a section 7 consultation pursuant to the Endangered Species Act of 1973, as amended (ESA) on EPA's proposed issuance of a Clean Air Act permit to Shell Offshore Inc (Shell) for exploratory drilling activities in the Beaufort Sea.

We understand Shell proposes to conduct oil and gas exploratory activities in the Beaufort Sea and has requested a Clean Air Act (CAA) permit from the EPA. The permit would authorize air emissions from the Frontier Discoverer drillship and its associated fleet on the Outer Continental Shelf (OCS) of the Beaufort Sea beyond the 25 mile Alaska seaward boundary. Drilling operations would commence in July 2010.

The Beaufort Sea is within the range of the spectacled eider (*Somateria fischeri*), Alaska-breeding Steller's eider (*Polysticta stelleri*), and polar bear (*Ursus maritimus*), which are listed as threatened under the ESA. In addition, yellow-billed loons (*Gavia adamsii*), a candidate species, also occurs in the Beaufort Sea, and the project is within the area proposed as polar bear critical habitat.

Oil and gas exploration projects in the OCS region of the Beaufort Sea are authorized and regulated by the Minerals Management Service (MMS). The activities proposed by Shell, which would be authorized by EPA, have been reviewed previously under ESA as part of the Service's section 7 consultation with MMS on oil and gas activities in the Beaufort and Chukchi Sea Program Areas (USFWS 2009) (USMMS 2009), and an intra-service consultation on the issuance of the Beaufort Sea Incidental Take Regulations (Beaufort Sea ITRs) under the Marine Mammal Protection Act (MMPA) (USFWS 2008).

Therefore, at EPA's request, we have reviewed proposed issuance of the CCA permit to evaluate if the proposed activities would result in impacts to listed species that were not considered in the previous section 7 consultations and resulting Biological Opinions

(BOs). Possible additional impacts identified by EPA are any that result from the duration of the CAA permit, and emissions of air pollutants.

CAA Permit Duration

EPA's CAA will permit activities from July 1 - December 31 for an unlimited number of years. However, the Biological Opinion with MMS on oil and gas activities in the Beaufort and Chukchi Sea Program Areas evaluated drilling activities that would occur for a limited number of years and cease prior to December 1 each year.

While the EPA air permit could conceivably drilling over a longer period than previously assessed, the actual amount and timing of drilling operations is ultimately determined by MMS. Changes in the duration or timing of drilling would require MMS to reinitiate section 7 consultation should the authorization result in any potential impacts to listed species not previously consulted upon.

As the EPA has stated they will require Shell to adhere to, and remain in compliance with, other applicable state and Federal regulations, the discrepancy between the duration of EPA's CAA permit and the time period previously evaluated for MMS is moot. We conclude that any previously unanticipated impacts that may arise from an extended authorization will ultimately require consultation.

Air Pollutant Emissions

The proposed CAA permit would authorize emissions of air pollutants from exploratory drilling and associated vessel activities. EPA estimated the maximum air pollutant levels that may result from these activities, and the worst-case scenario air pollutant concentrations are all below the primary and secondary National Ambient Air Quality Standards.

The Service considered the potential toxicological effects of emissions from exploratory drilling operation on listed and candidate species. The anticipated chemical emissions detailed in the permit include nitrogen oxides (NO_x), sulfur dioxide (SO₂), and sulfur compounds. We are not aware of any species specific NO_x, SO₂ or sulfur compound toxicity information for polar bears or listed and candidate avian species.

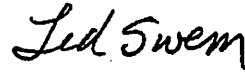
We also compared the list of anticipated emissions to those contaminants thought to affect the continued existence of the polar bear (Schliebe et al. 2006, Range Wide Status Review of the Polar Bear; page 152-175). None of the anticipated emissions are among those known to bioaccumulate or pose toxic effects to polar bears (petroleum hydrocarbons, persistent organic pollutants, mercury, and some other metals). We conclude that the emissions authorized in this permit are not likely to bioaccumulate or have toxic effects on polar bears or listed eiders or candidate species.

Conclusion

In conclusion, adverse effects to listed and candidate species, above those considered in previous BOs, are not anticipated to result from EPA's issuance of this CAA permit to

Shell. Therefore, section 7 consultation on the issuance of this permit is concluded informally by this letter.

Sincerely,



Ted Swem
Endangered Species Branch Chief

Literature Cited

Schliebe, S., T.J. Evans, K. Johnson, M. Roy, S. Miller, C. Hamilton, R. Meehan, and S. Jahrsdoerfer. 2006. Status assessment in response to a petition to list polar bears as a threatened species under the U.S. Endangered Species Act. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska. 262pp.

USFWS. 2008. Final Biological Opinion for Beaufort Sea Polar Bear Incidental Take Regulations. June 2008. 65pp.

USFWS. 2009. Final Biological Opinion for Beaufort and Chukchi Sea Program Area lease sales and associated seismic surveys and exploratory drilling. Consultation with MMS – Alaska OCS Region. Fairbanks Field Office. 168pp.

USMMS. 2009. Memorandum from Mr. Goll to Mr. Haskett : Section 7 Endangered Species Act – Proposed Polar Bear Critical Habitat. December 3, 2009. 8pp.

Mitigation Measures

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Appendix C: Mitigation Measures

1. Existing Mitigation Measures

This appendix contains the mitigation measures associated with existing leases in the Beaufort and Chukchi Seas. Mitigation measures are tied to specific lease sales. The mitigation measures may change between lease sales as conditions and technology change and as new information comes to light. Lease stipulations are requirements that lessees must follow. Information to Lessees (ITLs) and Notices to Lessees (NTLs) are provided to inform lessees of additional measures and best practices that lower the potential for detrimental impacts.

1.1. Mitigation Measures for the Polar Bear

1.1.1. Oil and Gas Activities on the Chukchi Sea OCS

The mitigation measures in effect for ongoing activities in the Chukchi Sea as a result of Sale 193 can be found in the Chukchi Sea Sale 193 EIS (USDOJ, MMS, 2007d), which can be found on the web at: http://www.mms.gov/alaska/ref/EIS%20EA/Chukchi_FEIS_193/feis_193.htm

The subset of these Stipulations, NTLs (notice to lessees) and ITLs (information to lessees) from Chukchi Sea Lease Sale 193 that most directly affect polar bears are reprinted here for the convenience of the reader:

Mitigation Measures Specific to the Lease-Sale Process for Sale 193.

Mitigation measures that are a standard part of the MMS program require seasonal windows for seismic operations; and require surveys to detect and avoid archaeological sites and biologically sensitive areas. Some MMS-identified mitigation measures are incorporated into OCS operations through cooperative agreements or efforts with industry and various State and Federal agencies.

Stipulation No. 1 – Protection of Biological Resources. If previously unidentified biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the OCS EIS/EA MMS 2007-026 MAY 2007 II-6 extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys. Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

- (1) Relocate the site of operations;
- (2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
- (3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or
- (4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such finding to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection. The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The

lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Summary of the Effectiveness of Stipulation No. 1. The level of protection provided by this measure will depend on several factors: the size of population that might be subjected to adverse impacts and the number of individuals within the population that would be afforded protection by this stipulation; the overall size of habitat used by the resource of concern and the portion of that habitat that may be affected by offshore oil and gas operations; and the uniqueness of the population or habitat. Thus, the effectiveness of the stipulation could vary widely. If only a few members of a large population or a small amount of a large habitat area were to be affected by oil and gas operations, the mitigative benefits would be minimal. However, if many individuals of a small population or most of the area of unique habitat is protected and the adverse effects are reduced or minimized because of this stipulation, then its effectiveness could be substantial. This stipulation lowers the potential adverse effects to lower trophic level organisms, primarily unknown kelp communities, and other unique biological communities, that may be identified during oil and gas exploration or development activities and provided additional protection. It also would provide protection to fish habitat from potential disturbance associated with oil and gas exploration, development, and production. This stipulation does not change the level of impacts that may occur from a large oil spill.

Stipulation No. 2 – Orientation Program. The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.211 and 250.241 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the Regional Supervisor, Field Operations. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence activities and pertinent mitigation. The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors. The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

Summary of the Effectiveness of Stipulation No. 2. This stipulation provides positive mitigating effects by requiring that all personnel involved in petroleum activities on the North Slope resulting from any leases issued from Sale 193 be aware of the unique environmental, social, and cultural values of the local Inupiat residents and their environment. This stipulation should help avoid damage or destruction of environmental, cultural, and archaeological resources through awareness and understanding of historical and cultural values. It also would help minimize potential conflicts between subsistence hunting and gathering activities and oil and gas activities that may occur. The extent of reduction offered by this stipulation is difficult to measure directly or indirectly. This stipulation provides protection to fish (including the migration of fish), pinnipeds, polar bears, bowhead whales, gray whales, and beluga whales from potential disturbances associated with oil and gas exploration, development, and production by increasing the awareness of workers to their

surrounding environment. It increases the sensitivity to and understanding by workers of the values, customs, and lifestyles of Native communities and reduces the potential conflicts with subsistence resources and hunting activities. This stipulation does not change the level of impacts that may occur from a large oil spill.

Stipulation No. 4 – Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources.

A lessee proposing to conduct exploration operations, including ancillary seismic surveys on a lease, during the periods and within the subsistence use areas related to bowhead whale, beluga whale, ice seals, walrus, and polar bears and their migrations and subsistence hunting as specified below, will be required to conduct a site-specific monitoring program approved by the Regional Supervisor, Field Operations (RS/FO); unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with appropriate agencies and co-management organizations, determines that a monitoring program is not necessary. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the North Slope Borough, the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. The RS/FO will provide the appropriate agencies and co-management organizations a minimum of 30 but no longer than 60 calendar days to review and comment on a proposed monitoring program prior to approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced. The monitoring program will be designed to assess when bowhead and beluga whales, ice seals, walrus, and polar bears are present in the vicinity of lease operations and the extent of behavioral effects on these marine mammals due to these operations. In designing the program, the lessee must consider the potential scope and extent of effects that the type of operation could have on these marine mammals. Experiences relayed by subsistence hunters indicate that, depending on the type of operations some whales demonstrate avoidance behavior at distances of up to 35 mi. The program must also provide for the following:

- Recording and reporting information on sighting of the marine mammals of concern and the extent of behavioral effects due to operations;
- Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project (BWASP) and other mandated aerial monitoring programs;
- Invite a local representative to be determined by consensus of the appropriate co-management organizations to participate as an observer in the monitoring program;
- Submitting daily monitoring results to the RS/FO;
- Submitting a draft report on the results of the monitoring program to the RS/FO within 60 days following the completion of the operation. The RS/FO will distribute this draft report to the appropriate agencies and co-management organizations; and
- Submitting a final report on the results of the monitoring program to the RS/FO. The final report will include a discussion of the results of the peer review of the draft report. The RS/FO will distribute this report to the appropriate agencies and co-management organizations. The lessee will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for bowhead whales. The lessee may be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for other co-managed marine mammal resources. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the appropriate

agencies and co-management resource organizations. The results of these peer reviews will be provided to the RS/FO for consideration in final approval of the monitoring program and the final report, with copies to the appropriate agencies and co-management organizations.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from NMFS and/or FWS, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. The lessee must advise the RS/FO when it is seeking an LOA or IHA in lieu of meeting the requirements of this stipulation and provide the RS/FO with copies of all pertinent submittals and resulting correspondence. The RS/FO will coordinate with the NMFS and/or FWS and will advise the lessee if the LOA or IHA will meet these requirements. The MMS, NMFS, and FWS will establish procedures to coordinate results from site-specific surveys required by this stipulation and the LOA's or IHA's to determine if further modification to lease operations are necessary. This stipulation applies to the areas and time periods listed below. This stipulation will remain in effect until termination or modification by the Department of the interior after consultation with appropriate agencies.

(Subsistence whaling and marine mammal hunting activities are by listed by community, see the Lease Sale 193 FEIS for more information on community subsistence hunting patterns, including polar bear.)

Summary of the Effectiveness of Stipulation No. 4. This stipulation provides site-specific information about the migration of bowhead whales and other marine mammals that could occur from oil and gas activities from the proposed lease sale. The information can be used to evaluate the threat of harm to the species and provides immediate information about the activities of bowhead whales, other marine mammals, and their response to specific events. This stipulation helps address NMFS concerns and recommendations to reduce potential effects to exploration activities. This stipulation also contributes incremental and important information to ongoing whale research and monitoring efforts and to the information database for bowhead whales. This stipulation helps reduce effects to subsistence-harvest patterns and to the overall sociocultural systems that place special value to bowhead whale harvests and the traditional activities of sharing this harvest with the other members of the community. This stipulation helps provide mitigation to potential effects of oil and gas activities to the local Native whale hunters and subsistence users. It is considered to be a positive action by the Native community under environmental justice.

Information to Lessees Clauses. Information to Lessees (ITL) clauses 1 through 15 are standard and apply to OCS activities in the Chukchi Sea. The primary purpose of an ITL is to provide lessees with additional information related to mitigating potential adverse impacts from future oil and gas activities.

No. 1 – Information on Community Participation in Operations Planning

No. 2 – Information on Bird and Marine Mammal Protection

No. 3 – Information on River Deltas

No. 4 - Information on Endangered Whales and MMS Monitoring Program

No. 5 – Information on the Availability of Bowhead Whales for Subsistence-Hunting Activities

No. 6 – Information on High-Resolution Geological and Geophysical Survey Activity

No. 7 – Information on the Spectacled Eider and Steller's Eider

No. 8 – Information on Sensitive Areas to be Considered in Oil-Spill-Response Plans

No. 9 – Information on Coastal Zone Management

No. 10 – Information on Navigational Safety

No. 11 – Information on Offshore Pipelines

No. 12 – Information on Discharge of Produced Waters

No. 13 – Information on Use of Existing Pads and Islands

- No. 14 – Information on Planning for Protection of Polar Bears
- No. 15 – Possible listing of Polar Bear under ESA
- No. 16 – Archaeological and Geological Hazards Reports and Surveys
- No. 17 – Response Plans for Facilities Located Seaward of the Coast Line
- No. 18 – Oil Spill Financial Responsibility for Offshore Facilities
- No. 19 – Good Neighbor Policy
- No. 20 – Rentals/Minimum Royalties and Royalty Suspension Provisions
- No. 21 – MMS Inspection and Enforcement of Certain Coast Guard Regulations
- No. 22 – Statement Regarding Certain Geophysical Data
- No. 23 – Affirmative Action Requirements
- No. 24 – Bonding Requirements

No. 1 - Information on Community Participation in Operations Planning. Lessees are encouraged to bring one or more residents of communities in the area of operations into their planning process. Local communities often have the best understanding of how oil and gas activities can be conducted safely in and around their area without harming the environment or interfering with community activities. Involving local community residents in the earliest stages of the planning process for proposed oil and gas activities can be beneficial to the industry and the community. Community representation on management teams, developing plans of operation, oil-spill response plans, and other permit applications can help communities understand permitting obligations and help the industry to understand community values and expectations for oil and gas operations being conducted in and around their area.

No. 2 - Information on Bird and Marine Mammal Protection. Lessees are advised that during the conduct of all activities related to leases issued as a result of this sale, the lessee and its agents, contractors, and subcontractors will be subject to the provisions of the following laws, among others: the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. 1361 et seq.); the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 et seq.); and applicable International Treaties. Lessees and their contractors should be aware that disturbance of wildlife could be determined to constitute harm or harassment and thereby be in violation of existing laws and treaties. With respect to endangered species and marine mammals, disturbance could be determined to constitute a “taking” situation. Under the ESA, the term “take” is defined to mean “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” Under the MMPA, “take” means “harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, or kill any marine mammal.” Violations under these Acts and applicable Treaties will be reported to National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (FWS), as appropriate. Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA, the ESA, or both, depending on the species that is taken, are met. Section 101(a)(5) of the MMPA, as amended, (16 U.S.C. 1371(a)(5)) provides a mechanism for allowing, upon request and during periods of not more than 5 consecutive years each, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region, provided that NMFS or FWS finds that the total of such taking during each 5-year (or less) period would have no more than a negligible impact on such species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

Applicants can receive authorization to incidentally, but not intentionally, take marine mammals under the MMPA through two types of processes: the Letter of Authorization (LOA) process and the Incidental Harassment Authorization (IHA) process. In either case, under the MMPA, incidental take

of marine mammals is prohibited unless authorization is obtained by those proposing the activity, whether or not the marine mammals are endangered or threatened.

Lessees are advised that, if marine mammals may be taken by harassment, injury, or mortality as a result of exploration activities, specific regulations and LOA's must be applied for and in place or IHA's must be obtained by those proposing the activity in order to allow the incidental take of marine mammals whether or not they are endangered or threatened. The regulatory process may require 1 year or longer; the IHA process takes about 5 months after receipt of a complete application. Based on guidance from the National Oceanographic and Atmospheric Administration (NOAA) Fisheries' Office of Protected Resources web site, if the applicant can show that: (a) there is no potential for serious injury or mortality; or, (b) the potential for serious injury or mortality can be negated through mitigation requirements that could be required under the authorization, the applicant should apply for an IHA and does not need an LOA for the activity. If the potential for serious injury and/or mortalities exists and no mitigating measures are available to prevent this form of 'take' from occurring, to receive authorization for the take, the applicant must obtain an LOA. The LOA requires that regulations be promulgated and published in the Federal Register outlining: (a) permissible methods and the specified geographical region of taking; (b) the means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for subsistence uses; and c) requirements for monitoring and reporting, including requirements for the independent peer review of proposed monitoring plans where the proposed activity may affect the availability of a species or stock for taking for subsistence uses. Under the MMPA, of those marine mammal species that occur in Alaskan waters, NMFS is responsible for species of the order Cetacea (whales and dolphins) and the suborder Pinnipedia (seals and sea lions) except walruses; FWS is responsible for polar bears, sea otters, and walruses. Requests for Incidental Take Authorizations (ITA's) should be directed towards the appropriate agency. Procedural regulations implementing the provisions of the MMPA are found at 50 CFR Part 18.27 for the FWS and at 50 CFR Part 216 for NMFS. If an applicant is requesting authorization for the incidental, but not intentional taking, of a marine mammal that is the responsibility of NMFS, a written request must be submitted to the NOAA Fisheries Office of Protected Resources and the appropriate NMFS Regional Office where the specified activity is planned. If an applicant is requesting authorization for the incidental, but not intentional, taking of a marine mammal that is the responsibility of FWS, a written request must be submitted to the FWS Regional Office where the specific activity is planned. More information on this process, and application materials, are available from the NOAA Fisheries Office of Protected Resources website (www.nmfs.noaa.gov/prot_res/PR2/Small_Take/smalltake.info.htm).

According to NOAA Fisheries Small Take web site, most LOA's and IHA's to date have involved the incidental harassment of marine mammals by noise. Activities with the greatest potential to harass by noise include seismic airguns, ship and aircraft noise, high-energy sonars, and explosives detonations. Please note that the NOAA Fisheries web site on small-take authorizations indicates the following timetables for LOA and IHA decisions: "Decisions on LOA applications (includes two comment periods, possible public hearings and consultations) may take from 6-12 months. The IHA decisions normally involve one comment period and, depending on the issues and species involved, can take anywhere from 2- 6 months"

(www.nmfs.noaa.gov/prot_res/PR2/Small_Take/smalltake_info.htm#applications).

Section 7(b)(4) of the ESA allows for the incidental taking of endangered and threatened species under certain circumstances. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed. Of particular concern is disturbance at major wildlife-concentration areas, including bird colonies, marine mammal haulout and breeding areas, and wildlife refuges and parks. Maps depicting major wildlife concentration areas in the lease area are available from the MMS Regional Supervisor, Field Operations. Lessees also are encouraged to confer with FWS and NMFS in planning

transportation routes between support bases and lease holdings. Lessees also should exercise particular caution when operating in the vicinity of species that are not listed under the ESA but are proposed for listing, designated as candidates for listing, or are listed as a “Species of Concern” or whose populations are believed to be in decline, such as the yellow-billed loon, walrus, and polar bear. Generally, behavioral disturbance of most birds and mammals found in or near the sale area would be unlikely if aircraft and vessels maintain at least a 1-mile horizontal distance and aircraft maintain at least a 1,500-foot (ft) vertical distance above known or observed wildlife-concentration areas, such as seabird colonies, the spring lead system, and marine mammal haulout and breeding areas. For the protection of endangered whales and marine mammals throughout the lease area, MMS recommends that all aircraft operators maintain a minimum 1,500-ft altitude when in transit between support bases and exploration sites. The MMS encourages lessees and their contractors to minimize or reroute trips to and from the leasehold by aircraft and vessels when endangered whales are likely to be in the area. Human safety will take precedence at all times over these recommendations.

No. 6 - Information on Seismic Survey Activity. Lessees are advised of the potential effect of geophysical activity to bowhead whales, other marine mammals, and subsistence hunting activities. High resolution seismic surveys are distinguished from 2D/3D seismic surveys by the magnitude of the energy source used in the survey, the size of the survey area, the number and length of arrays used, and duration of the survey period. High-resolution seismic surveys are typically conducted after a lease sale in association with a specific exploration or development program or in anticipation of future lease sale activity. Lessees are advised that all seismic survey activity conducted in Chukchi Sea Planning Area, either under the geological and geophysical (G&G) permit regulations at 30 CFR 251 or as an ancillary activity in support of an exploration plan or development and production plan under 30 CFR 250, is subject to environmental and regulatory review by the MMS. The MMS has standard mitigating measures that apply to these activities, and lessees are encouraged to review these measures before developing their applications for G&G permits or planning ancillary activities on a lease. Copies of the nonproprietary portions of all G&G permits applications will be provided by MMS to appropriate agencies, co-management organizations, and directly affected communities. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the North Slope Borough, the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, and the Nanuk Commission. The MMS may impose restrictions (including the timing of operations relative to open water) and other requirements (such as having a locally approved coordinator on board) on seismic surveys to minimize unreasonable conflicts between the seismic survey activities and subsistence whaling activities.

Lessees and applicants are advised that MMS will require any proposed seismic activities to be coordinated with the appropriate agencies, co-management organizations, and directly affected subsistence communities to identify potential conflicts and develop plans to avoid these conflicts. Copies of the results of any required monitoring plans will be provided by MMS to the NSB, directly affected subsistence communities, and appropriate agencies and subsistence organizations for comment.

No. 8 - Information on Sensitive Areas to be Considered in the Oil-Spill Response Plans (OSRP).

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, other biological resources, or cultural resources, and for their importance to subsistence harvest activities, and should be considered when developing OSRP's. Coastal aggregations of polar bears during the open water/broken-ice period are particularly vulnerable to the effects of an oil spill, which lessees must account for in their OSRP's. Identified areas and time periods of special biological and cultural sensitivity for the Chukchi Sea include:

- 1) Elson Lagoon;
- 2) Barrow Polar Bear Aggregation Area, August-October;
- 3) Spring Lead System April-June;
- 4) Peard Bay/Franklin Spit;
- 5) Kuk Lagoon;
- 6) Icy Cape and associated Barrier Islands;
- 7) Kasegaluk Lagoon and Naokok, Kukpowruk, Akunik, and Utukok Passes through the Barrier Islands;
- 8) Ledyard Bay Critical Habitat Area;
- 9) Cape Lisburne, May-September;
- 10) Marryat Inlet;
- 11) Cape Thompson, May-September;
- 12) On-and offshore waters from Point Hope to Cape Thompson, including Aiautak and Akoviknak Lagoons;
- 13) Kugrua River, May-October;
- 14) Kuchiak River, Jan-Dec;
- 15) Kuk River, May-October;
- 16) Kokolik River, May-October;
- 17) Kukpowruk River, May-October;
- 18) Pitmegea River, May-October; and
- 19) Utukok River, May-October.

These areas are among areas of special economic or environmental importance required by 30 CFR 254.26 to be considered in the OSRP. Lessees are advised that they have the primary responsibility for identifying these areas in their OSRP's and for providing specific protective measures. Additional areas of special economic or environmental importance may be identified during review of exploration plans and development and production plans. Industry should consult with U.S. Fish and Wildlife Service or State of Alaska personnel to identify specific environmentally sensitive areas within National Wildlife Refuges or state special areas which should be considered when developing a project-specific OSRP. Consideration should be given in an OSRP as to whether use of dispersants is an appropriate defense in the vicinity of an area of economic or environmental importance. Lessees are advised that prior approval must be obtained before dispersants are used.

No. 14 - Information on Planning for Protection of Polar Bears. Polar bears are part of a dynamic rather than a static system. Changes in their distributions and populations in recent years indicate that adaptive management is required to adequately mitigate potential impacts to their populations (i.e., specific mitigation measures developed today may not be applicable 5, 10, or 20 years from now). The U.S. Fish and Wildlife Service (FWS) is the management agency responsible for polar bear management; as such, they have the most current information about the status of polar bear populations, the issues facing them, and the most recent research findings applicable to them. Therefore, MMS will be implementing increased coordination with FWS for the protection of polar bears. Lessees are advised to consult with FWS and local Native communities while planning their activities and before submission of their Oil-Spill Response Plans (OSRP) to ensure potential threats to polar bears are adequately addressed based on the most current knowledge regarding their habitat use, distribution, and population status, and to ensure adequate geographic coverage and protection are provided under the OSRP. Coastal aggregations of polar bears during the open water/broken ice period are particularly vulnerable to the effects of an oil spill, which lessees must address in their OSRP's. For example, well known polar bear aggregations have occurred at Point Barrow in close proximity to subsistence-harvested whale carcass remains. Measures to ensure adequate timely geographic coverage and protection of polar bears may include, but are not limited to, the pre-staging

of oil-spill equipment at or near locations of polar bear aggregation to support oil-spill-response operations. Lessees are encouraged to consult and coordinate with FWS, local Native communities, and the Nanuk Commission to develop plans and mitigation strategies in their OSRP to prevent adverse effects to known bear aggregations. Making subsistence harvested whale carcasses unavailable to polar bears on land during the fall open-water period may reduce polar bear aggregations and thus lower the potential for an oil spill to impact polar bears. As part of the MMS review of proposed activities and mitigation measures, the Regional Supervisor, Field Operations (RS/FO) will notify FWS of the review of proposed Exploration Plans and Development and Production Plans (and associated OSRP) and make copies of these documents available to FWS for review and comment. Lessees are encouraged to continue existing or initiate new training programs for oil-spill-response teams in local villages to facilitate local participation in spill response and cleanup. This effort allows local Native communities to use their knowledge about sea ice and the environment in the response process and can enhance their ability to provide protection to key resources, including polar bears. Under the Marine Mammal Protection Act (MMPA), the incidental take of marine mammals is prohibited unless authorization is obtained by those proposing the activity, whether or not the marine mammals are endangered or threatened. To protect polar bears and other marine mammals, MMS encourages OCS operators to obtain an incidental take authorization (ITA) from FWS under the MMPA prior to any operation. Incidental takes of polar bears are allowed only if an ITA is obtained from the FWS pursuant to the regulations in effect at the time. Obtaining an ITA will ensure that lessees' operations are planned and conducted with the most current knowledge of polar bears' habitat use, distribution, and population status. The FWS must be in receipt of a petition for incidental take prior to initiating the regulatory process. An ITA must be requested annually. Lessees are advised that polar bears may be present in the area of operations, particularly during the solid ice period. Lessees should conduct their activities in a way that will limit potential encounters and interaction between lease operations and polar bears. Lessees are advised to contact FWS regarding proposed operations and actions that might be taken to minimize interactions with polar bears. Lessees also are advised to consult OCS Study MMS 93-0008, Guidelines for Oil and Gas Operations in Polar Bear Habitats. Lessees are reminded of the provisions of the 30 CFR 250.300 regulations, which prohibit unauthorized discharges of pollutants into offshore waters. Trash, waste, or other debris that might attract polar bears or might be harmful to polar bears should be properly stored and disposed of to minimize attraction of, or encounters with, polar bears.

No. 15 – Possible listing of Polar Bear under ESA. Lessees are advised that the U.S. Fish and Wildlife Service is proposing to list the polar bear (*Ursus maritimus*) as a threatened species under the Endangered Species Act and has initiated a comprehensive scientific review to assess the current status and future of the species. During 2007, the FWS will gather more information, undertaking additional analyses, and assessing the reliability of relevant scientific models before making final decision whether to list the species. Please refer to <http://alaska.fws.gov/fisheries/mmm/polarbears/issues.htm> for additional information. If the polar bears are ultimately listed under the ESA, then MMS will consult with FWS under Section 7 of the ESA, and may be required to apply additional mitigation measures on OCS activities to ensure appropriate protection.

II.B.4. Mitigation Measures for Seismic Operations in the Chukchi Sea.

The following stipulations are standard for MMS-permitted geological and geophysical (G&G) activities and would be included for all seismic activities considered. On-lease, ancillary seismic activities would use a selected suite of these mitigation measures that are appropriate for the specific operation:

1. No solid or liquid explosives shall be used without specific approval.
2. Operations shall be conducted in a manner to ensure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses

of the area. Any difficulty encountered with other uses of the area or any conditions that cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the Regional Supervisor/Resource Evaluation. Serious or emergency conditions shall be reported without delay.

3. Operators must maintain a minimum spacing of 15 miles between the seismic-source vessels for separate simultaneous operations. The MMS must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum spacing.

4. Permit applicants shall use the lowest sound levels feasible to accomplish their data-collection needs.

II.B.4.a. Measures to Mitigate Seismic-Surveying Effects.

The measures outlined below are based on the protective measures in MMS' most recent marine seismic survey exploration permits and the MMS' Biological Evaluation for ESA Section 7 consultation with NMFS on Arctic Region OCS activities dated March 3, 2006 (USDOJ, MMS, 2006b), recent Section 7 consultations with the USFWS regarding threatened eiders, and the recently completed Programmatic Environmental Assessment of Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006 (USDOJ, MMS, 2006a). The protective measures (e.g., ramp up) also are accepted by the scientific community and the resource agencies (e.g., NMFS and FWS). Although not empirically proven, anecdotal evidence on the displacement of marine mammals by sounds (e.g., those sounds generated by ramp up) and professional reasoning indicate that they are reasonable mitigation measures to implement.

1. Exclusion Zone – A 180/190-decibel (dB) isopleth-exclusion zone (also called a shutdown zone) from the seismic-survey-sound source shall be free of marine mammals before the survey can begin and must remain free of mammals during the survey. The purpose of the exclusion zone is to protect marine mammals from Level A harassment (injury/harm). The 180-dB (Level A harassment-injury) applies to cetaceans and the Pacific walrus, and the 190-dB (Level A harassment-injury) applies to pinnipeds other than the Pacific walrus and to polar bears.

2. Monitoring of the Exclusion Zone – Individuals (marine mammal biologists or trained observers) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free exclusion zone and monitor for avoidance or take behaviors. Visual observers monitor the exclusion zone to ensure that marine mammals do not enter the exclusion zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic survey work after shut down. The NMFS will set specific requirements for the monitoring programs and observers.

3. Shut Down – The survey shall be suspended until the exclusion zone is free of marine mammals. All observers shall have the authority to, and will, instruct the vessel operators to immediately stop or de-energize the airgun array whenever a marine mammal is seen within the exclusion zone. If the airgun array is completely powered down for any reason during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the exclusion zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.

4. Ramp Up – Ramp up is the gradual introduction of sound to deter marine mammals (and other fish and wildlife) from potentially damaging sound intensities and from approaching the exclusion zone. This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at least 20-40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated at night or when monitoring the exclusion zone is not

possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line transects, for maintenance needs or during periods of impaired visibility (e.g., darkness, fog, high sea states), and does not require a 30- minute clearance of the exclusion zone before the airgun array is again ramped up to full output.

5. Field Verification – Before conducting the survey, the operator shall verify the radii of the exclusion zones within real-time conditions in the field. This provides for more accurate exclusion-zone radii rather than relying on modeling techniques before entering the field. Field verification techniques must be consistent with NMFS-approved guidelines and procedures. When moving a seismic-survey operation into a new area, the operator shall verify the new radii of the exclusion zones by applying a sound-propagation series.

6. Monitoring of the Seismic-Survey Area – Aerial-monitoring surveys or an equivalent monitoring program acceptable to the NMFS may be required.

7. Reporting Requirements – Reporting requirements, such as the monitoring plans required by FWS for polar bears and walrus prior to the start of seismic activities, provide the regulating agencies with specific information on the monitoring techniques to be implemented and how any observed impacts to marine mammals will be recorded. In addition, operators must report immediately any shut downs due to a marine mammal entering the exclusion zones and provide the regulating agencies with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the exclusion zones.

8. Temporal/Spatial/Operational Restrictions – Dynamic management approaches to avoid or minimize exposure, such as temporal or spatial limitations are based on marine mammals or birds being present in a particular place or time, or being engaged in a particularly sensitive behavior (such as feeding).

- • Seismic surveys must not occur in the Chukchi Sea spring lead system before July 1 of each year, unless authorized by NMFS, to provide bowhead cow/calf pairs additional protection.
- Operators are required to provide information regarding their operations within the spring lead system upon request of MMS. The MMS may request information regarding number of vessels and their dates/points of entry into and exit from the spring lead system.
- • No seismic vessel activity, including resupply vessels and other related traffic, will be permitted within the Ledyard Bay Critical Habitat Area after July 1 of each year, unless human health or safety dictates otherwise. Incursions for human health or safety purposes shall be reported within 24 hours to MMS. Other incursions will be considered noncompliance with this condition.
- • Survey-support aircraft will avoid flying over the Ledyard Bay Critical Habitat Area below an altitude of 1,500 feet (450 meters) after July 1 of each year, unless human health or safety dictates otherwise. Incursions for human health or safety purposes shall be reported within 24 hours to MMS. Other incursions will be considered noncompliance with this condition. In other coastal areas, seismic-survey-support aircraft should maintain at least 1,500 ft (450 m) over beaches, lagoons, and nearshore waters as much as possible.
- • Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m bathymetric contour. High-intensity lights will be turned off in inclement weather when a vessel is not actively participating in seismic surveys; however, navigation lights, deck lights, and interior lights could remain on for safety.

1.1.1.2 Oil and Gas Activities on the Beaufort Sea OCS

The mitigation measures in effect for ongoing OCS activities that result from previous Beaufort Sea sales can be found in USDOl, MMS (2003a) and at www.mms.gov/alaska/ref/EIS%20EA/BeaufortMultiSaleFEIS186_195_202/2003_001vol1.pdf. These mitigation measures include stipulations that have mitigation effects for polar bears, and standard stipulations that were primarily designed to protect other species, but which also mitigate effects for polar bears. The portions of these stipulations that mitigate potential effects to polar bears are briefly described below:

Protection of Biological Resources.

If biological populations or habitats that require additional protection are identified in the lease area by the MMS Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

- (1) Relocate the site of operations;
- (2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect on the resource identified or that a special biological resource does not exist;
- (3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or
- (4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected. If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such findings to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection. The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the location information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee regarding permissible actions.

Orientation Program.

The lessee shall include in any exploration or development and production plans a proposed orientation program for all personnel. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing biological resources and habitats, including endangered species and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be attended at least once a year by all personnel. The MMS and FWS have published guidelines for oil and gas operations in polar bear habitats that describe further measures to reduce potential impacts to polar bears. This includes properly storing food, trash and any liquid products (antifreeze, diesel, paint, etc.) so that they are inaccessible to bears and do not act as an attractant; properly designing and lighting facilities and temporary camps so that they do not encourage bears to approach and the risk of bear-human interactions are minimized.

Industry Site-Specific Bowhead Whale-Monitoring Program.

Lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration will be required to conduct a site-specific monitoring program. The program must also provide for the following: recording and reporting information on sighting of other marine mammals and the extent of behavioral effects due to operations. During seismic operations, operators are required to ramp up gradually which presumably gives marine mammals time to move away from the

zones of influence. Operators are also required to have marine mammal observers on watch at all times while operating, and to shut down if marine mammals are seen within zones of influence (190 dB for polar bears and ice seals, 180dB for cetaceans and Pacific walrus.)

Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities.

Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting).

The lessee shall make every reasonable effort to assure that exploration, development, and production activities are compatible with whaling and other subsistence hunting activities and will not result in unreasonable interference with subsistence harvests. Lease-related use will be restricted when the RS/FO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting activities. In enforcing this stipulation, the RS/FO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts. Subsistence whaling activities occur generally during the following periods:

August to October: Kaktovik whalers use the area circumscribed from Anderson Point in Camden Bay to a point 30 kilometers north of Barter Island to Humphrey Point east of Barter Island. Nuiqsut whalers use an area extending from a line northward of the Nechelik Channel of the Colville River to Flaxman Island, seaward of the Barrier Islands.

September to October: Barrow hunters use the area circumscribed by a western boundary extending approximately 15 kilometers west of Barrow, a northern boundary 50 kilometers north of Barrow, then southeastward to a point about 50 kilometers off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Cape Halkett.

The time periods identified above coincide with when polar bears come ashore in these areas. Protective measures identified to reduce conflicts with subsistence whaling also reduce potential conflicts with polar bear movements in these areas.

In addition, some of the standard information to lessee clauses provide guidance on mitigation measures for polar bears. These clauses, which apply to OCS activities in the Beaufort Sea, include the following:

Information on Bird and Marine Mammal Protection.

Lessees are advised that during the conduct of all activities related to leases issued as a result of this sale, the lessee and its agents, contractors, and subcontractors will be subject to the provisions of the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. 1361 et seq.); the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 et seq.); and applicable International Treaties. Lessees and their contractors should be aware that disturbance of wildlife could be determined to constitute harm or harassment and, thereby, be in violation of existing laws and treaties. With respect to endangered species and marine mammals, disturbance could be determined to constitute a “taking” situation. Under the ESA, the term “take” is defined to mean “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” Under the MMPA, “take” means “harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal.” These Acts and applicable Treaties require violations be reported to the NMFS or the FWS, as appropriate.

Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA and/or the ESA are met. Section 101(a)(5) of the MMPA (16 U.S.C. 1371(a)(5)) allows for the taking of small numbers of marine mammals incidental to a specified activity within a specified geographical area. Section 7(b)(4) of the ESA (16 U.S.C. 1536(b)(4)) allows for the incidental taking of endangered and threatened species under certain circumstances. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed.

Under the MMPA and ESA, the NMFS is responsible for species of the order Cetacea (whales and dolphins) and the suborder Pinnipedia (seals and sea lions) except walrus; the FWS is responsible for polar bears, sea otters, walrus, and birds. Procedural regulations implementing the provisions of the MMPA are found at 50 CFR Part 18.27 for FWS, and at 50 CFR Part 228 for NMFS.

Lessees are advised that specific regulations must be applied for and in place and that a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) must be obtained by those proposing the activity to allow the incidental take of marine mammals, whether or not they are endangered or threatened. The regulatory process may require 1 year or longer. Of particular concern is disturbance at major wildlife concentration areas, including bird colonies, marine mammal haulout and breeding areas, and wildlife refuges and parks. Maps depicting major wildlife concentration areas in the lease area are available from the RS/FO. Lessees also are encouraged to confer with the FWS and NMFS in planning transportation routes between support bases and lease holdings.

Lessees should exercise particular caution when operating in the vicinity of species whose populations are known or thought to be declining and which are not protected under the ESA; such as, Pacific walrus. These regulations have been extended until August 2, 2011 (71 FR 43925).

Incidental take regulations are promulgated only upon request, and the FWS must be in receipt of a petition prior to initiating the regulatory process. Incidental, but not intentional, taking is authorized only by U.S. citizens holding an LOA issued pursuant to these regulations. An LOA or IHA must be requested annually. Behavioral disturbance of most birds and mammals found in or near the lease area would be unlikely if aircraft and vessels maintain at least a 1-mile horizontal distance and aircraft maintain at least a 1,500-foot vertical distance above known or observed wildlife concentration areas, such as bird colonies and marine mammal haulout and breeding areas. For the protection of endangered whales and marine mammals throughout the lease area, it is recommended that all aircraft operators maintain a minimum 1,500-foot altitude when in transit between support bases and exploration sites. Lessees and their contractors are encouraged to minimize or reroute trips to and from the leasehold by aircraft and vessels when endangered whales are likely to be in the area. Human safety will take precedence at all times over these recommendations. The current Beaufort Sea Incidental Take Regulations for polar bear include mitigation, monitoring and reporting requirements for operators. Each request for an LOA is carefully reviewed by the FWS, and LOAs may include conditions to afford additional protections to sensitive areas, such as denning habitats.

Information on Polar Bear Interaction.

Lessees are advised that polar bears may be present in the area of operations, particularly during the solid-ice period. Lessees should conduct their activities in a manner which will limit potential encounters and interaction between lease operations and polar bears. The FWS is responsible for the protection of polar bears under the provisions of the MMPA of 1972, as amended. Lessees are advised to contact the FWS regarding proposed operations and actions that might be taken to minimize interactions with polar bears. Lessees also are advised to consult "OCS Study MMS 93-0008, Guidelines for Oil and Gas Operations in Polar Bear Habitats."

The FWS must be in receipt of a petition for incidental take prior to initiating the regulatory process. Incidental takes of polar bears are allowed only if an LOA or an IHA is obtained from the FWS pursuant to the regulations in effect at the time. An LOA or an IHA must be requested annually. Lessees are reminded of the provisions of the 30 CFR 250.300 regulations which prohibit discharges of pollutants into offshore waters. Trash, waste, or other debris which might attract polar bears or be harmful to polar bears should be properly stored and disposed of to minimize attraction of, or encounters with, polar bears.

Information on Sensitive Areas to be Considered in the Oil-Spill Contingency Plans (OSCP)

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, other biological resources, or cultural resources, and for their importance to subsistence-harvest activities, and should be considered when developing OSCP. Identified areas and time periods of special biological and cultural sensitivity include:

- (1) the lead system off Point Barrow, April-June;
- (2) the saltmarshes from Kogru Inlet to Smith Bay, June-September;
- (3) the Plover Islands, June-September;
- (4) the Boulder Patch in Stefansson Sound, June-October;
- (5) the Camden Bay area (especially the Nuvugag and Kaninniivik hunting sites), January, April-September, November;
- (6) the Canning River Delta, January-December;
- (7) the Barter Island - Demarcation Point Area, January-December;
- (8) the Colville River Delta, January-December;
- (9) the Cross, Pole, Egg, and Thetis Islands, June-October;
- (10) the Flaxman Island waterfowl use and polar bear denning areas, January-December;
- (11) the Jones Island Group (Pingok, Spy, and Leavitt Islands) and Pole Island are known polar bear denning areas, November-April; and
- (12) the Sagavanirktok River delta, January-December.

These areas are among areas of special biological and cultural sensitivity to be considered in the OSCP required by 30 CFR 250.300. Lessees are advised that they have the primary responsibility for identifying these areas in their OSCP and for providing specific protective measures. Additional areas of special biological and cultural sensitivity may be identified during review of exploration plans and development and production plans.

Industry should consult with FWS or State of Alaska personnel to identify specific environmentally sensitive areas within National Wildlife Refuges or State special areas which should be considered when developing a project-specific OSCP. Consideration should be given in an OSCP as to whether use of dispersants is an appropriate defense in the vicinity of an area of special biological and cultural sensitivity. Lessees are advised that prior approval must be obtained before dispersants are used.

Additional mitigation may be required by FWS through the MMPA and the ESA. The FWS has MMPA Incidental Take Regulations currently in effect for the Beaufort Sea (71 *FR* 43926-43953). These regulations remain in effect from August 2, 2006, through August 2, 2011. The regulations for Beaufort Sea oil and gas activities encompass exploration, development, and production activities. Mitigation measures applied through the Incidental Take Regulations may include FLIR imagery flights to determine the location of active dens, avoiding all denning activity by a minimum of 1 mile, intensified monitoring

of an area or avoiding the area during the denning period. In some instances, work camps or facilities may be relocated to avoid potential interactions with polar bears. Aerial surveys may be required to locate bears in the area. These mitigation measures will vary depending upon the type of industry activity, the location, time of year and other factors.

Under the MMPA and ESA, the FWS is responsible for polar bears, sea otters, walruses, and migratory birds. Procedural regulations implementing the provisions of the MMPA for FWS are found at 50 CFR Part 18.27. Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA and/or the ESA are met. Section 101(a)(5) of the MMPA (16 U.S.C. 1371(a)(5)) allows for the taking of small numbers of marine mammals incidental to a specified activity within a specified geographical area, as long as such take is determined to have a “negligible” effect on the population. Section 7(b)(4) of the ESA (16 U.S.C. 1536(b)(4)) allows for the incidental taking of endangered and threatened species under certain circumstances, as long as such take is not determined to have a population-level effect. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed.

Incidental, but not intentional, taking is authorized only by U.S. citizens holding an LOA issued pursuant to these regulations. An LOA or IHA must be requested annually. Behavioral disturbance of most birds and mammals found in or near the lease area would be unlikely if aircraft and vessels maintain at least a 1-mile horizontal distance and aircraft maintain at least a 1,500-foot vertical distance above known or observed wildlife concentration areas, such as bird colonies and marine mammal haulout and breeding areas. For the protection of endangered whales and marine mammals throughout the lease area, it is recommended that all aircraft operators maintain a minimum 1,500-foot altitude when in transit between support bases and exploration sites. Lessees and their contractors are encouraged to minimize or reroute trips to and from the leasehold by aircraft and vessels when endangered polar bears are likely to be in the area. Human safety will take precedence at all times over these recommendations. The current Beaufort Sea ITRs for polar bear include mitigation, monitoring and reporting requirements for operators. Each request for an LOA is carefully reviewed by the FWS, and LOAs may include conditions to afford additional protections to sensitive areas, such as denning habitats.

Current ITR for the Beaufort Sea remain in effect until August 2, 2011. When the polar bear was listed under the ESA on May 15, 2008, FWS conducted an intra-agency consultation on the MMPA Beaufort Sea ITR and determined that the LOA process under the MMPA was not likely to jeopardize the continued existence of the polar bear. The FWS also has determined that the LOA process provides sufficient protection for the polar bear to serve as adequate consultation under the ESA. Therefore, a company has met its obligations under the ESA as long as they obtain and follow the requirements of an LOA. An LOA will not be issued to a company unless their proposed activity has been determined to have no more than negligible effects on the polar bear. Mitigation measures required through the LOA process typically include notifying FWS within 24 hours of any sighting of or interaction with a polar bear.

Additional mitigation may be required by FWS through the MMPA and the ESA. The FWS has MMPA ITR currently in effect for the Beaufort Sea (71 *FR* 43926-43953). These regulations remain in effect from August 2, 2006, through August 2, 2011. The regulations for Beaufort Sea oil and gas activities encompass exploration, development, and production activities. Mitigation measures applied through the ITR generally include FLIR imagery flights to determine the location of active dens, avoiding all denning activity by a minimum of 1 mile, intensified monitoring of an area or avoiding the area during the denning period. In some instances, work camps or facilities may be relocated to avoid potential interactions with polar bears. Aerial surveys may be required to locate bears in the area. These

mitigation measures will vary depending upon the type of industry activity, the location, time of year and other factors.

1.2. Mitigation Measures for Threatened and Endangered Birds

Oil and Gas Activities on the Chukchi Sea and Beaufort Sea OCS

The following mitigation measures are in effect to protect ESA-listed and other marine and coastal birds during Federal and State seismic activities and exploration drilling operations in the Chukchi Sea and Beaufort Sea. The Federal measures represent the collective result of recent Section 7 consultations for lease sales (Lease Sales 193, 186, 195, and 202) and programmatic seismic activities in the Chukchi and Beaufort seas.

Seismic Activities:

- No seismic activity, including resupply vessels and other related traffic, will be permitted within the Ledyard Bay spectacled eider critical habitat area following July 1 of each year, unless human health or safety dictates otherwise.
- Seismic-survey support aircraft must avoid overflights across the Ledyard Bay spectacled eider critical habitat area below an altitude of 1,500 ft (450 m) after July 1 of each year, unless human health or safety dictates otherwise. Seismic-survey support aircraft would maintain at least a 1,500 ft (305 m) altitude over beaches, lagoons, and nearshore waters as much as possible. Designating aircraft flight routes will be established for situations when aircraft associated with seismic activity cannot maintain >1,500 ft above sea level (ASL) over the Ledyard Bay Critical Habitat Area.
- Ramping-up procedures will be used when initiating airgun operations.
- Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m-bathymetric contour. High-intensity lights will be turned off in inclement weather when the seismic vessel is not actively conducting seismic surveys. However, navigation lights, deck lights, and interior lights could remain on for safety.
- All bird-vessel collisions (with vessels or aircraft) shall be documented and reported within 3 days to MMS. Minimum information will include species, date and time, location, weather, and if a vessel is involved in its operational status when the strike occurred. Bird photographs are not required but would be helpful in verifying species. Operators are advised that FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.
- Operators must maintain a minimum spacing of 15 mi between the seismic-source vessels for separate operations.
- Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic-substance spill. If vessels transit through the spring lead system before June 10, they may encounter concentrations of listed eiders. The FWS therefore requires that wildlife hazing equipment (including Breco buoys or similar equipment) be prestaged and readily accessible by personnel trained in their use, either on the vessel, at Point Lay or Wainwright, or on an on-site oil-spill-response vessel, to ensure rapid deployment in the event of a spill.

Spectacled and Steller's eiders could experience direct mortality through collisions with vessels, aircraft, or drilling structures. Specific measures to be implemented that would minimize the potential for adverse effects to ESA-protected eiders from MMS-authorized activities on existing leases in the Chukchi Sea are (USDOI, MMS, 2007, Final Notice of Sale for Lease Sale 193):

Stipulation No. 7. Measures to Minimize Effects to Spectacled and Steller's Eiders During

Exploration Activities. This stipulation will minimize the likelihood that spectacled and Steller's eiders will strike drilling structures or vessels. The stipulation also provides additional protection to eiders within the blocks listed below and Federal waters landward of the sale area, including the Ledyard Bay Critical Habitat Area, during times when eiders are present.

(A) General conditions: The following conditions apply to all exploration activities.

- (1) An EP must include a plan for recording and reporting bird strikes. All bird collisions (with vessels, aircraft, or drilling structures) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, identification of the vessel, and aircraft or drilling structure involved and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Lessees are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.
- (2) The following conditions apply to operations conducted in support of exploratory and delineation drilling.
 - (a) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within or traversing the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, to the maximum extent practicable. If surface vessels must traverse this area during this period, the surface vessel operator will have ready access to wildlife hazing equipment (including at least three *Breco* buoys or similar devices) and personnel trained in its use; hazing equipment may be located onboard the vessel or on a nearby oil spill response vessel, or in Point Lay or Wainwright. Lessees are required to provide information regarding their operations within the area upon request of MMS. The MMS may request information regarding number of vessels and their dates of operation within the area.
 - (b) Except for emergencies or human/navigation safety, surface vessels associated with exploration and delineation drilling operations will avoid travel within the Ledyard Bay Critical Habitat Area between July 1 and November 15. Vessel travel within the Ledyard Bay Critical Habitat Area for emergencies or human/navigation safety shall be reported within 24 hours to MMS.
 - (c) Aircraft supporting drilling operations will avoid operating below 1,500 feet above sea level over the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, or the Ledyard Bay Critical Habitat Area between July 1 and November 15, to the maximum extent practicable. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the FWS, during review of the EP. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.

(B) Lighting Protocols. The following lighting requirements apply to activities conducted between April 15 and November 15 of each year.

- (1) **Drilling Structures:** Lessees must adhere to lighting requirements for all exploration or delineation drilling structures so as to minimize the likelihood that migrating marine and coastal birds will strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration or delineation drilling structures to minimize the likelihood that birds will strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures while operating on a lease or if staged within nearshore Federal waters pending lease deployment.

Measures to be considered include but need not be limited to the following:

- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
- Types of lights;
- Adjustment of the number and intensity of lights as needed during specific activities;
- Dark paint colors for selected surfaces;
- Low-reflecting finishes or coverings for selected surfaces; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational, and management approaches that could be applied to their specific facilities and operations to reduce outward light radiation. Lessees must provide MMS with a written statement of measures that will be or have been taken to meet the lighting objective, and must submit this information with an EP when it is submitted for regulatory review and approval pursuant to 30 CFR 250.203.

(2) Support Vessels: Surface support vessels will minimize the use of high-intensity work lights, especially when traversing the listed blocks and federal waters between the listed blocks and the coastline. Exterior lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog); otherwise they will be turned off. Interior lights and lights used during navigation could remain on for safety.

For the purpose of this stipulation, the listed blocks are as follows:

NR02-06, Chukchi Sea: 6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey: 6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert: 6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island: 6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West: 6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal 6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow: 6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright: 6002-6006, 6052, 6053

NS04-08, (Unnamed): 6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Nothing in this stipulation is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

Note: The MMS and FWS have reconsulted under Section 7 of the ESA on a case-by-case basis for exceptions to these mitigation measures. For the 2006-2008 summers, industry has been required by the NMFS to deploy an array of passive acoustic monitoring devices, three stations were within the outer margin of the LBCHA after July 1, as a condition of their Incidental Harassment Authorization under the MMPA. The MMS or NMFS determined, and the FWS concurred, that a maximum number of three trips into and out of the LBCHA under the shortest possible, pre-determined route was not likely to adversely affect threatened eiders. Other industry vessel traffic associated with MMS-authorized activities has been directed to use nearshore areas not included in the LBCHA or have used the margin of the LBCHA in consideration of maritime safety - all consistent with the intent of these mitigation measures.

Mitigation Measures for the existing and anticipated Beaufort Sea Lease Sales on State of Alaska lands specific to protection of bird resources (ADNR 2008) include:

22. Birds:

- a. Permanent, staffed facilities must be sited to the extent feasible and prudent outside identified brant, white-fronted goose, snow goose, tundra swan, king eider, common eider, Steller's eider, spectacled eider, and yellow-billed loon nesting and brood rearing areas.
- b. Due to high concentrations of staging and molting brant and other waterbirds within the coastal habitats along the Teshekpuk Lake Special Area (TLSA) and other areas, operations that create high levels of disturbance, including but not limited to dredging, gravel washing, and boat and barge traffic along the coast, will be prohibited from June 20 to September 15 within one-half mile of coastal salt marshes, specifically In addition, Tracts 228 and 231 are subject to the same restrictions between May 15 and July 30 to protect large concentrations of breeding snow geese. The construction and siting of facilities within one mile of these areas may be allowed on a case-by-case basis if the Director, DO&G and ADF&G determine that no other feasible and prudent location exists.

Similarly, the NSB has passed local ordinances that we assume apply to existing state leases:

- 1a. Lessees shall comply with the Recommended Protection Measures for Spectacled and Steller's Eiders developed by the FWS to ensure adequate protection of spectacled eiders during the nesting and brood rearing periods.
6. Aircraft Restrictions: To protect species that are sensitive to noise or movement, horizontal and vertical buffers will be required, consistent with aircraft, vehicle and vessel operations regulated by NSB Code §19.70.050(I)(1) which codifies NSBCMP policy 2.4.4.(a). Lessees are encouraged to apply the following provisions governing aircraft operations in and near the proposed sale area:
 - a. From June 1 to August 31, aircraft overflights must avoid identified brant, white-fronted goose, tundra swan, king eider, common eider, and yellow-billed loon nesting and brood rearing habitat, and from August 15 to September 15, the fall staging areas for geese, tundra swans, and shorebirds, by an altitude of 1,500 feet, or a lateral distance of one mile.

