An Assessment of the Potential Effects

of

Oil and Gas Leasing Activities

in the

Beaufort Sea and Chukchi Sea Planning Areas

on

Steller's Eider (*Polysticta stelleri*), Spectacled Eider (*Somateria fischeri*), Kittlitz's Murrelet (*Brachyramphus brevirostris*), Yellow-billed Loon (*Gavia adamsii*), and Polar Bear (*Ursus maritimus*)

Minerals Management Service
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1. The Proposed Action:

The Minerals Management Service (MMS) has responsibility for the development of oil, gas, and other resources on America's outer continental shelf (OCS). In Alaska, this effort has included a number of lease sales in the Beaufort Sea and Chukchi Sea Planning Areas (Figure A). At this time industry holds leases on fewer than 500 lease blocks from a number of previous lease sales in the Chukchi Sea and fewer than 250 lease blocks from a number of 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).

For OCS activities MMS is authorized to use an incremental step process for section 7 consultation. Using this process, MMS and the Fish and Wildlife Service conducted consultations for threatened spectacled (*Somateria fischeri*) and Alaska-breeding Steller's (*Polysticta stelleri*) eiders for MMS's lease sales. These consultations authorized exploration activities in both Planning Areas and concluded the described hypothetical developments that may result from lease sales would not jeopardize the continued existence of listed eiders. Both the Northstar and Liberty projects underwent subsequent, site-specific consultation as individual development projects are also reevaluated for impacts to listed species in the next incremental step (in this case development).

Since these incremental step consultations were performed, new information has become available regarding the status of listed eiders. In addition, the polar bear (*Ursus maritimus*) was listed as a threatened species pursuant to the ESA on May 15, 2008, and the yellow-billed loon (*Gavia adamsii*) was designated a candidate species on March 25, 2009.

As the MMS has existing leases and is considering additional lease sales in the Chukchi (Lease Sales 212 and 221) and Beaufort (Lease Sales 209 and 217) seas (also called the Alaskan Arctic OCS), the MMS has been working with the FWS to make sure Section 7 consultations for OCS activities in the 2007-2012 5-Year Program Areas are as current, thorough, and accurate as possible. Towards that end, this assessment evaluates the potential impacts of oil and gas leasing, exploration and development in the lease sale areas (the Action) on listed spectacled and Alaska-breeding Steller's eiders, critical habitat, and polar bears, and the candidate species Kittlitz's murrelet (*Brachyramphus brevirostris*) and yellow-billed loon. Specifically, the assessment evaluates the projected impacts of MMS's described reasonable exploration and development scenarios, which include substantial mitigation measures, developed for oil and gas activities for all previous lease sales and future lease sales in both the Chukchi and Beaufort seas.

The MMS believes that preparing a single assessment document for this Action will provide for a thorough and comprehensive analysis of all potential impacts to listed species and critical habitat from oil and gas activities in the Beaufort Sea and Chukchi Sea OCS. The types of activities that could result from existing leases in each sea are the same as those that could result from the proposed lease sales.

The MMS requested Section 7 consultation be conducted incrementally pursuant to 50 CFR 402.14(k), with leasing and exploration considered and authorized in the first incremental step. However, as required the consultation will also consider impacts through the endpoint of the actions as described in the hypothetical development scenarios for each sea. This will allow analysis to determine whether these scenarios would jeopardize listed species or adversely modify critical habitat. This comprehensive analysis considers the potential direct and indirect effects of the Action, as well as cumulative effects and effects of interrelated and interdependent activities, when added to the environmental baseline, to provide an aggregative analysis of impacts to listed species and critical habitat.

The MMS has prepared a Draft Environmental Impact Statement (DEIS) for Oil and Gas Lease Sales 209, 212, 217, and 221 in the Beaufort Sea and Chukchi Sea Planning Areas, November 2008. The program areas (Chukchi Sea in blue and Beaufort Sea in red, Figure A), are smaller areas of the Planning Areas. Existing leases are within these areas. Much of the following material in this assessment is based on information from the DEIS.

Table A. Active lease summary for the Arctic Planning Area of the OCS, current as of March 18, 2009. Leases may be relinquished by the lessee at any time and returned to MMS. Hectares are rounded to the nearest hectare. Northstar is currently in production, while Liberty is in the construction stage.

Sale-Planning Area	Hectares	Active Leases	Production
BF -Beaufort Sea	3,033	2	Northstar
124-Beaufort Sea	2,235	1	Northstar
144-Beaufort Sea	3,334	2	Liberty
186-Beaufort Sea	73,576	34	
195-Beaufort Sea	245,760	117	
202-Beaufort Sea	198,580	90	
193-Chukchi Sea	1,116,277	487	none
Totals:	1,642,795	733	

Some editing was completed to make the draft sections more readable and consistent from their original DEIS form. The original sections can be found in the DEIS, as are any other sections, maps, figures, tables, appendices and literature references cited. Figures A and B, Tables 1 and 2, and Appendix 1 (Mitigation Measures) are specific to this assessment.

THE PROPOSED ACTION:
Our Proposed Action is to continue to authorize oil and gas exploration and development activities on the Alaskan Arctic OCS consistent with our previous leasing programs (Figure B) and those specified in our current 5-Year Program. At this time industry holds leases on fewer than 500 lease blocks from a number of previous lease sales in the Chukchi Sea and fewer than 250 lease blocks from a number of 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). Our current 5-Year program proposes additional lease sales in the Beaufort Sea and Chukchi Sea Planning Areas. Program areas are typically smaller portions of the larger Planning Areas (Figure A). Sales 209 and 217 in the Beaufort Sea would offer for lease the entire program area as scheduled in the 2007-2012 5-Year Program (Figure A). The Beaufort Sea program area encompasses approximately 6,123 whole or partial blocks that cover approximately 33,194,467 acres (about 13,426,469 hectares). Sales 212 and 221 in the Chukchi Sea would offer for lease the entire area as scheduled in the 2007-2012 5-Year Program (Figure A). The Chukchi Sea program area encompasses 7,326 whole or partial blocks that cover approximately 40,192,866 acres (about 16.1 million hectares). These areas, minus any blocks currently leased at the time of the sale, would be offered in the proposed sales. The proposed action covers existing leases and potential future leases acquired in the program areas shown in Figure A.

2. EXPLORATION AND DEVELOPMENT SCENARIOS.

Our reasonably foreseeable activities are dependent upon scenarios.

2.4. Scenario Framework. [note: original numbering sequence from DEIS was retained]

2.4.1. Assumptions regarding OCS Exploration and Development Scenarios. For analysis purposes, MMS developed scenarios of activities that could occur subsequent to the proposed sales. The primary purpose of the scenarios in this document is to provide a common basis for analysis of potential environmental impacts associated with future activities, assuming these activities occur as presented in the scenario.

The scenarios are hypothetical. In these scenarios, we assume a reasonable scale of development considering the petroleum potential, available technologies and industry trends. The scenarios, although subjective, are based on professional judgment and as much information as possible, including petroleum geology, engineering and technology, and economic trends. The scenarios are generalized, because the size and location of future commercial pools are unknown at the present time. Industry will take the lead in exploring these frontier areas, but we have no direct knowledge of industry strategies. Scenarios are not intended to be firm predictions. Actual operations would be conducted according to site-specific conditions, and no one can identify these locations at the present time.

All scenarios are hypothetical, but they can be described as *reasonably foreseeable* or *speculative*. A *reasonably foreseeable* scenario is interpreted here to mean a continuation of current trends into the near-term future. The timeframe considered to be "foreseeable" is not fixed, and is based on professional judgment and the availability and reliability of relevant information. Clearly, the shorter the timeframe, the more likely that predictions would be accurate. In contrast, a *speculative* scenario would involve a significant change from historical trends or timeframes beyond several decades into the future. Speculative scenarios are much more uncertain, because there is no accurate way to define the timing or characteristics of operations in the distant future, particularly when projects could require technologies that are unknown today.

Exploration activities are classified in our analysis as being reasonably foreseeable, because it is logical to assume that when companies buy leases, they will try to explore their leases. Primary lease terms are typically 10 years, so exploration operations will take place within the foreseeable timeframe. The lease will expire at the end of its primary term unless (a) the lease is producing oil and/or gas in paying quantities, (b) the lessee is conducting drilling or well-reworking to establishing production in paying quantities from the lease, or (c) the Regional Supervisor has approved a suspension of operations or a suspension of production on the lease. Exploration operations (marine seismic, well drilling, and ancillary activities) have occurred for several decades in the areas, so the characteristics of these activities are well known. We also include limited development of some discoveries in the reasonably foreseeable scenario; not all discoveries would be commercially viable.

In general, however, extensive development activities are more realistically described as being speculative, because offshore facilities are rare in the Beaufort and none have been installed in the Chukchi. Widespread development in these OCS areas after the next few lease sales would be a change from historical trends over the past 3 decades. Although exploration technologies have advanced, many of the large geologic prospects have been drilled without making commercial discoveries. Although these areas are only partly tested (36 wells have been drilled in program areas), the challenges that have hindered past operations also are likely to affect future operations. The high petroleum resource potential in the Beaufort Sea and Chukchi Sea undoubtedly will continue to attract industry interest in leasing and exploration, but development will not occur unless some of the economic and engineering challenges can be ameliorated.

Both the Beaufort and Chukchi provinces could contain large amounts of oil and gas. The 2006 petroleum assessment conducted by MMS (USDOI, MMS, 2006e) estimated that these two areas could hold mean technically recoverable oil resources of 23 billion barrels (Bbbl) (85% of the entire Alaska OCS) and the mean technically recoverable gas resources of 105 trillion cubic feet (Tcf) (80% of the entire Alaska OCS). Although these resource numbers are impressive, resource potential should not be confused with proven reserves. Undiscovered *resources* have not been located and, when discovered, they must be feasible to develop to become producing fields. Reserves are proven oil and gas accumulations that are feasible to recover with a profit acceptable to the field operator. Typically, a large portion of the petroleum potential could occur in pools that are too small, too hard to identify, or too costly to develop. This portion of the resource potential is unlikely to become producing reserves, because companies will not purposely develop uneconomic projects. It also is unlikely that industry would test all of the pools mapped in an area, because this would require hundreds of wells and the cost would be prohibitive. A more realistic view is that industry will high-grade mapped prospects and drill the largest pools first. If commercial discoveries are made, these first projects would become infrastructure hubs around which smaller 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.

The scale of future activities will depend on many factors, the most important of which are the physical challenges of the arctic environment (extreme seasonal conditions); technology advancements to operate safely in a difficult, new setting; regulatory constraints (access to prime exploration areas); industry funding (bidding in lease sales, exploration 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. Reviewing the history of the Beaufort Sea OCS, 10 OCS lease sales have been held since 1979. 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 drilling. Exploration drilling rates are rather slow (31 wells since 1979). Thirty-one exploration wells tested 20 prospects (1 well per 30 leases). Nine of the exploration wells were classified as discoveries (capable of producing in paying quantities), confirming that potentially commercial pools occur in six prospects. Only one of the six (17%) potentially commercial discoveries has been developed (Northstar). Thus, the commercial success rate for the prospects tested is 5% (1/20). The commercial success rate for all blocks leased is only 0.01%. The obvious conclusion is that leasing is a poor indication of later commercial development.

As a result of nearly 30 years of leasing and exploration activities, three production facilities have been installed offshore in the Beaufort Sea. The Endicott field was the first offshore facility in State waters (2 mi offshore), and artificial gravel production islands are connected to shore by a causeway. The Northstar field was the second offshore facility and produces a small amount of oil (approximately 18% of the 208-million barrel [MMbbl] field) from OCS tracts by wells drilled from a gravel island in State waters (5 mi offshore). The Oooguruk field began producing in July 2008 and is producing oil from an artificial gravel island located 3 mi offshore in 5 ft of water. Plans for the Liberty field now include oil recovered from Federal OCS tracts using ultralong-reach wells drilled from Endicott or onshore sites. The history of these fields illustrates the difficulties faced by operations in Arctic waters. The Endicott field was discovered in 1978 and production startup occurred 1986 (8 years later). The Northstar field was leased in 1979, discovered in 1984 (formerly called Seal Island), and production startup was in 2001 (17 years after discovery). The Oooguruk field was discovered in 2003 and began producing in 2008 (5 years after discovery). The Liberty field was leased in 1979, discovered in 1982 (formerly called Tern Island), and production startup could occur in 2011 (29 years after discovery). Compared to these nearshore (<5 mi) shallow-water (<40 ft) projects, the challenges for large stand-alone projects in remote (>50 mi) and deeper water (>100 ft) sites would be far more difficult.

The scenarios incorporate current resource assessments and industry trends. The MMS 2006 assessment (USDOI, MMS, 2006e) for the Chukchi Sea area indicates that a mean resource potential of 15.38 Bbbl of oil could be recoverable using current technologies. The mean oil resource potential is modeled to occur in a mean (average) number of 154 pools grouped into 27 different geology plays. To have a realistic chance of commercial development, oil prices must be high enough to cover the high costs for operations. The 2006 assessment indicates that there are no economically recoverable resources in this area at oil prices lower than $40/barrel (bbl). This fact highlights the investment risk faced by industry because the average price for North Slope crude oil over the past 10 years has been $31.16 (State of Alaska, Dept. of Natural Resources [ADNR], 2007d). Assuming that commercial-size discoveries are made and future prices average $60/bbl (in constant dollars) over the next several decades, the assessment indicates that 7.05 Bbbl (about 46% of the conventionally recoverable endowment) could be viable to develop, if discovered. Higher average oil prices would increase the amount of oil that is recoverable but does not necessarily increase the level of exploration because costs also increase with higher prices.

We can assume that with the high costs of exploration wells (more than $50 million per well), companies would 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. Because there is no infrastructure, the first stand-alone field in the Chukchi would have to contain 1 Bbbl (or more) to justify development. The 2006 assessment indicates that 13 commercial-size oil pools (1 Bbbl) of this size could be present in the group of 154 pools that represent the mean undiscovered oil potential in the Chukchi. Leasing and drilling will be needed to discover these large pools.

As a result of two pre-2008 lease sales, five exploration wells were drilled from a total inventory of 483 leases (or 1% of the blocks leased). These first exploration wells tested some of the largest mapped prospects in the area. Although many other prospects remained to be tested, it is optimistic to assume that industry would be willing to drill 73 more wells in this high-cost area (73 wells at $50 million per well is $3.65 billion). However, using the historical drilling rate in the Arctic OCS (approximately 1 well/year), we can make an optimistic estimate that industry could drill up to 20 more exploration wells on existing leases or on leases following the proposed Chukchi Sea lease sales under the current 5-Year Program. Assuming that the discovery efficiency is directly correlated to the number of wells, 20 exploration wells could translate into the discovery of 28% (20/73) of the economically recoverable resources. The discovered resource fractions of the total of 7 Bbbl would amount to 1-2 Bbbl. This is consistent with using the minimum economic threshold of a 1-Bbbl development as the scenario for a Proposed Action.

We often refer to the scenario as being optimistic, because we assume that all of the discoveries would be developed. In fact, companies could have higher standards for a commercially viable project and marginally economic or difficult projects would not be developed, even though they theoretically are economic. Historically, only one of the six discoveries in the Beaufort and Chukchi OCS has been developed (Northstar). Discovering a potentially commercial pool is just the beginning of a lengthy regulatory process with progressively higher expenditures by industry. Numerous factors (industry funding, engineering feasibility, regulatory hurdles) could easily delay or eliminate the development of a promising discovery.

The petroleum development scenario in these two areas was defined in the Programmatic EIS for the 2007-2012 OCS leasing program (USDOI, MMS, 2007c). Some discoveries in the Chukchi Sea could be uneconomic to develop, whereas similar-size discoveries in the Beaufort might be developed because they are closer to existing infrastructure and oil could be recovered at a lower cost.

The key points on scenario development are:

1) Scenarios, although subjective, are and should be based on as many facts as reasonably possible. The interrelationships between geology, engineering, and economic reality are not arbitrary.
2) A continuation of exploration activities is the logical continuation of historical trends in these frontier areas. A change to widespread development activities would not occur unless existing cost, technology, logistics, and environmental challenges are ameliorated and/or overcome.
3) It is very unlikely that large fractions of the undiscovered petroleum potential would be discovered and developed in the foreseeable future. The pace of exploration has been slow in these frontier areas for many reasons that are not expected to change anytime soon.
4) Our scenarios generated for environmental impact analysis and the technological and environmental challenges they identify are not likely to influence industry decisions. High risk, high reward investments are typical of the petroleum business, and the opportunities in the Beaufort and Chukchi are comparable to elsewhere in the world.

2.4.2. Assumptions regarding Trans-Alaska Pipeline System (TAPS). An important assumption in our scenario is that TAPS will remain operational as the only oil-export system from northern Alaska to outside markets. The pipeline has been operating for 30 years, and the license was renewed recently for another 30 years. However, some serious issues will be facing TAPS in the foreseeable future. Widely held opinions are that the lower limit for profitable operations could be approximately 400,000 bbl per day (bpd) (depending on oil prices). Throughput rates lower than 300,000 bpd will require more modifications to the pipeline and pump stations. And physical flow limits for this 48-inch pipeline could occur at rates below 200,000 bpd. Oil transport from North Slope fields through TAPS has declined from a peak rate of 2 million bpd in 1988 to a present rate of approximately 750,000 bpd (2007). If this rate of decline continues, TAPS could reach one or more of the operational limits within the next 20 years.

Production from new fields would provide oil for the pipeline and extend the life of this important transportation system. Over the past 30 years TAPS has carried 15-25% of annual domestic oil production to market. If TAPS is shut down, future oil production probably would have to rely on marine tankers to carry oil to outside markets. This would be a far more costly and operationally problematic option. For purposes of this analysis, we assume that an oil pipeline (either TAPS in its present form or a future redesigned pipeline) will continue to carry oil from fields in northern Alaska, including the Beaufort and Chukchi OCS areas.

2.4.3. Assumptions regarding Natural Gas Development. For analysis purposes, the scenario assumes that offshore gas production would not occur without infrastructure to export natural gas to market. For decades, the associated gas produced from North Slope oil fields has been used as fuel in facilities or reinjected to increase oil recovery. This situation is likely to continue for at least another decade because no gas transportation project has been approved. There is approximately 35 Tcf of proven gas resources that could be easily produced when a transportation system is built. In addition, an estimated 200 Tcf of gas resources could be in undiscovered pools throughout northern Alaska (Houseknecht and Bird, 2005). The construction of a major gas transportation project would be very costly (up to $30 billion), and no proposal to date has overcome the many economic challenges (see Appendix E). Developing new gas fields also would be very costly (perhaps $1-2 billion for a 1-Tcf gas field). 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. The MMS has decided, for planning purposes, to include a generic gas-development scenario in our analysis.

Appendix E of the DEIS discussed the factors that could influence the characteristics of future gas development in the Beaufort and Chukchi OCS sale areas. It is important to recognize that seismic survey technologies cannot definitely 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 pools to drill and avoid gas pools. 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 pools often yield hydrocarbon liquids (condensate), so gas and condensate could be recovered through the same facilities. Sometimes even the definition of oil or gas is difficult because it is a transitional substance (volatile oil with high gas content, wet gas with high condensate content).

For these reasons, it is more realistic to consider an integrated oil/gas development scenario, where either oil or gas (or a mixture) is discovered and produced. A way to scale the estimates assumed for the scenarios is by using a general barrels-of-oil energy equivalent (BOE). For purposes of analysis, we assume a conversion factor of 1 bbl of oil to 6 million cubic feet of gas. For example, an oil field containing 1 Bbbl would be equivalent to a 6 Tcf gas field. Lean crude oil and dry gas are end-members of a spectrum of potential hydrocarbon compositions. Mixed oil and gas is more likely to occur in nature than these end-members. We assume that gas-saturated oil reservoirs contain associated-dissolved gas with a mixture ratio of 1,000 cubic feet per barrel. Likewise, we assume that wet gas reservoirs contain 25 bbl of condensate per 1 MMcf of gas.

Oil and gas are end-members of a continuous spectrum of possible hydrocarbon production. For purposes of analysis, most of the activities and infrastructure are very similar regardless of whether the production is oil or gas. As such, operations could have the same potential impacts. 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. Gas fields usually have fewer total production wells than corresponding oil fields. Subsea pipeline installation also would be very similar (probably trenched offshore). The timing of production could be different for associated reservoirs, because gas typically is reinjected to maximize oil recovery. However, we can assume that gas will eventually be produced and extend the operational life of oil facilities.

Although most oil and gas operations are similar, there is a significant difference between oil and gas accidents. Gas is more explosive and its associated liquids (condensate) are lighter density and more volatile. Consequently, spills from gas wells or pipeline accidents would have a relatively short residence time in the environment and tend not be transported over long distances. In contrast, crude oil spills would persist longer in the environment and, thus, potentially cause more impacts.

Although oil development is more likely to occur before gas development because of there is an existing transportation system (TAPS), we optimistically assume that a gas pipeline would be constructed to carry future gas production to market by 2018. After reviewing different gas-transportation strategies in Appendix E (DEIS), we concluded that a large overland pipeline system is a more feasible and likely alternative than liquefied natural gas export by tankers or other marine transportation strategies. A gas pipeline that begins operating in a decade or so could be used by new OCS gas fields, because it would take at least 10 years to discover and develop fields in the Beaufort and Chukchi OCS. Although we 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 least impediments associated with engineering, economic, and political issues.

2.4.4. Typical Activities

The following scenarios are in terms of oil development but similar activities would occur for gas development.

Beaufort Sea OCS. The reasonable foreseeable future scenario covers exploration activities (marine seismic surveys and drilling of test or delineation wells) because it is logical to assume that companies will attempt to explore their leases. The MMS issued leases under Lease Sales 186, 195, and 202 and has scheduled two more Beaufort Sea lease sales in the 2007-2012 5-Year Program. The Beaufort Sea program area is a smaller region of the Beaufort Sea Planning Area (Figure A). The Northstar and Liberty developments are anticipated to be producing in the reasonably foreseeable future.

In terms of potential impacts from exploration, we anticipate no more than six seismic surveys or two active drill ships in the Beaufort Sea during any particular open-water season. These are the upper limits for these activities for purposes of our impact analysis (Table 2).

Commercial development in the OCS would represent a departure from historical trends in the Beaufort Sea. Existing or new leases in the Beaufort Sea could result in new discoveries and while considered to be speculative on an individual sale basis, our calculations that consider the past and proposed sales (five sales total) result in a 67% chance of development. In contrast to the Chukchi Sea, prospects in the Beaufort Sea are closer to shore and existing infrastructure, so Prudhoe Bay is considered the anchor field and development of smaller fields could be feasible. Of the 67% chance for development, the type of development, i.e., the most likely development scenario (4.8%) assumes the eventual discovery and development of three new fields with a combined production of 500 MMbbl. One production facility could arise from these new fields.

The total lifecycle (exploration through production) of the Beaufort Sea scenario is estimated to be approximately 30-40 years.

Chukchi Sea OCS: Four lease sales were held on different parts of the Chukchi shelf between 1988 and 1991, but only a small fraction of blocks were leased by industry (483 leases, approximately 5% of the blocks offered). Five exploration wells were drilled in 1989-1991 to test five large prospects, none of which were listed as discoveries. By 1998, all of the former leases either expired or were relinquished.

Industry interest has increased recently for exploration in the Chukchi, partly prompted by high oil and gas prices and advancements in various engineering technologies that could help overcome the difficult conditions in this area. The Chukchi 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. The MMS' 2006 petroleum assessment indicates that the mean conventionally recoverable oil resource is 15.38 Bbbl with a 5% chance of 40.08 Bbbl (USDOI, MMS, 2006e). The mean undiscovered gas resources total 76.77 Tcf with a 5% chance of 209.53 Tcf. Most government and industry experts agree that this province could hold large oil and gas fields comparable to any frontier area in the world.

The 2007-2012 5-Year Program (USDOI, MMS, 2007c) included three sales in the Chukchi Sea Planning Area, including Chukchi Sale 193, which was held in February 2008. Two more sales (212 and 221) are proposed in the next few years. The Chukchi Sea program area is a smaller region of the Chukchi Sea Planning Area (Figure A). The reasonably foreseeable future scenario covers exploration activities (marine seismic surveys and drilling of test or delineation wells) because it is logical to assume that companies will attempt to explore existing or any new leases acquired in the two proposed Chukchi Sea sales. In terms of potential impacts from exploration, we anticipate no more than six seismic surveys and two active drill ships in the Chukchi Sea during any particular open-water season. These are the upper limits for these activities for purposes of our Section 7 consultation and impact analysis (Table 2).

Commercial development in the OCS would represent a departure from historical trends in the Chukchi Sea. Existing or new leases in the Chukchi Sea could result in new discoveries and while considered to be speculative on an individual sale basis, our calculations that consider the past and proposed sales (three sales total) result in a 27% chance of development. The most likely outcome is no development (73%).

However, of that 27%, the most likely development scenario assumes the eventual discovery and development of a 1-Bbbl oil field. The greatest potential for discovering this field from existing or proposed lease sales under the 5-Year Program is about 8%. This field would be the first stand-alone commercial offshore oil field in the Chukchi Sea OCS. One production facility could arise from this new field. The analysis of impacts associated with this 1-Bbbl field was first covered in the Sale 193 EIS (USDOI, MMS, 2007d) and that analysis remains essentially unchanged because the same scenario covers any additional leases acquired during the two proposed Chukchi Sea lease sales.

Our development scenario for the Chukchi Sea includes transportation activities. Oil production from the Chukchi is assumed to cross NPR-A as an elevated pipeline connected to the existing TAPS pipeline. Natural gas discoveries could be developed when a transportation system is constructed and has available capacity for new gas supplies from the Chukchi. There is no gas-export system from northern Alaska at the present time, and none is expected for at least a decade. Any gas production from the Chukchi would be prohibitively expensive, unless several large gas fields were discovered to support the cost of new infrastructure. We assume that a key part of this infrastructure would be an overland gas pipeline across NPR-A to the Prudhoe Bay area. Without gas pipelines to market, associated gas recovered with oil production could be used as fuel for facilities and/or reinjected to increase oil recovery. Even if a gas pipeline to market is constructed, associated gas in oil fields would not be available for export until oil fields are depleted. A large-diameter gas pipeline across NPR-A could be chilled and buried in the oil pipeline corridor.

Table 2: Timeline of exploration activities on the Alaskan Arctic OCS from existing leases and those from proposed lease sales under the current 5-year Program. Development and Production (DP) activities are not reasonably foreseeable but are described and evaluated for potential effects.

	Chukchi Sea OCS		Beaufort Sea OCS	
Year	Seismic	Drill Rig	Seismic	Drill Rig
2009	≤6	≤2	≤6	≤2
2010	≤6	≤2	≤6	≤2
2011	≤6	≤2	≤6	≤2
2012	≤6	≤2	≤6	≤2
2013	≤6	≤2	≤6	≤2
2014	≤6	≤2	≤6	≤2
2015	≤6	≤2	≤6	≤2
2016	≤6	≤2	≤6	≤2
2017	≤6	≤2	≤6	≤2
2018	≤6	≤2	≤6	≤2
2019	≤6	≤2	≤6	≤2
2020	≤6	≤2	≤6	≤2
2021	≤6	≤2	≤6	≤2
2022	≤6	≤2	≤6	≤2

Chukchi Sea OCS	Beaufort Sea OCS
DP analysis assumes:	DP analysis assumes:
1 Bbbl field discovered	3 fields = 500MMbbl discovered
new production platform	new production platform
other land-based facilities	other land-based facilities
new pipeline across NPR-A	

The following sections are organized according to the different phases of petroleum activities, starting with exploration, followed by development and production, and finally abandonment.

2.4.4.1. Exploration Activities.
General information
Seismic surveys for exploration have been conducted in the Alaskan Arctic OCS and are likely to continue. They are anticipated to continue each year through the primary lease term (10 years). This work is needed to identify prospective blocks for bidding in lease sales and to optimize drilling sites on tracts acquired in lease sales. Seismic surveys would involve both 2D and 3D survey methods. Because approximately 92,000 line-miles of 2-dimensional (2D) seismic data were collected in the Beaufort OCS between 1965 and 1997, future seismic surveys in the Beaufort Sea would be mostly 3-dimensional (3D) surveys focusing on drilling targets. Seismic surveys could occur during the summer (July-Oct.) using vessels and during winter (Jan.-May) as "hardwater" or "on-ice" surveys using vibroseis methods. Similarly, approximately 80,000 line-miles of 2D seismic data were collected in the Chukchi OCS between 1970 and 1990, and subsequent seismic surveys (post-2006) are likely to be 3D surveys.

Future marine (open-water) seismic surveys could occur during the summer (July-November). Survey operations could be conducted during each calendar year, with individual surveys focusing on a different prospect or area. Marine surveys may be split into two phases, one starting early in the summer (July) and finishing in the late season (November) to accommodate ice conditions in the proposed survey areas. Seismic surveys in the Beaufort OCS would probably be coordinated with surveys in the Chukchi OCS and could employ the same vessels. Additional details about seismic survey equipment and methods are given in the seismic-survey programmatic DEIS (USDOI, MMS, 2006a).

With better resolution of the subsurface structure using 3D seismic data, well locations could be proposed. Prior to drilling exploration wells, site-clearance surveys would examine the area for geologic hazards, archeological features, and biological populations. High-resolution, low-energy, geophysical surveys and ancillary studies required for permits to drill would be conducted during the open-water season.

Exploration drilling could occur at a rate of one to four wells per year, which includes dry wells, discovery wells, and delineation wells. Drilling operations are expected to take between 30-90 days at each well site, depending on the depth to the target formation, downhole difficulties during drilling, and logging/testing operations. This drilling timeframe does not include unexpected regulatory or legal delays.

Information Specific to Beaufort Sea
Thirty-one wells have already been drilled on the Beaufort Sea OCS and we estimate that up to 34 wells could be drilled to discover and delineate new fields. 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 (failed test) wells, the minimum number of future wells is estimated to be 12 wells.

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. Ice platforms are constructed by continuously flooding an area of landfast ice until a platform of ice has been created that is resting on the sea floor. The process is restricted to depths of less than 10 m (~33 ft). Most Federal lease areas in the Beaufort Sea are or would be in water greater than 10 m deep. This process can only be used in areas where ice movement is minimal (in the landfast ice zone, nearshore). Otherwise, ice movement will interfere with creating the ice platform or perhaps even move the ice platform. It is possible that an ice platform could be used as a drilling platform in shallow protected areas, for example behind the barrier islands, or in State waters where directional drilling could reach out to a Federal lease site. While it is possible that ice platforms may be used for exploratory wells, it is unlikely in most Federal lease areas in the Beaufort Sea. While not prohibited, MMS does not anticipate much development in Federal waters less than 10 m deep in the Beaufort Sea because it involves a very limited area. MMS has in the past approved one plan for drilling from an ice platform in the Beaufort Sea (McCovey), however the plan did not move forward because it did not meet coastal consistency requirements. It is unlikely that gravel islands would be constructed to drill exploration wells, because they would be prohibitively expensive.

We assume that two mobile drill rigs or vessels would operate in the arctic OCS during any drilling season. Mobile, bottom-founded platforms (set on the seafloor) could be used to drill exploration wells in water depths of 10-20 m (33-66 ft) during winter or summer months. During the summer season (July-Oct.) drillships 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.

Information Specific to Chukchi Sea

Exploration drilling is assumed to begin in the year after Sale 212 (in 2010) and continue at an average rate of one to two wells per year completed by one drilling rig during the summer open-water season (July-Nov.). Some years could experience twice this activity level (2-4 wells by 2 independent drilling rigs). Drilling operations are expected to be 30-90 days at each well site, depending on the depth to the target formation, downhole difficulties during drilling, and logging/testing operations. This drilling timeframe does not include unexpected regulatory or legal delays.

Five exploration wells already have been drilled in the Chukchi program area and we estimate that up to 38 more wells could be drilled to discover and delineate new fields. 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 (failed test) wells, the minimum number of future wells would be nine wells.

Considering water depth and the remoteness of this area, drilling operations are likely to employ drillships or ice-strengthened jack-up rigs with icebreaker support vessels. Water depths greater than (>)100 ft and possible pack-ice incursions during the open-water season would preclude the use of bottom-founded drilling platforms in deeper water. Using drillships allows the operator to temporarily move off the drill site, if sea or ice conditions require it, and the suspended well is controlled by blowout-prevention equipment installed on wellheads on the seabed. 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.

2.4.4.2. Discharges from Exploration Wells. Geologic mapping indicates that the prospects likely to be drilled have reservoir depths ranging from 3,000-15,000 ft in the subsurface. For purposes of analysis, we assume that the typical exploration well would be 10,000 ft. We assume that authorized onsite waste discharges from drilling operations will be 100% of the rock cuttings and 20% of the drilling mud (80% of the drilling mud is reconditioned/reused). For a typical 10,000-ft exploration well, the on-site discharges would be 125 tons of mud per well (625 tons total with 20% waste) and 825 tons of rock cuttings. These estimates are in dry weight with 1 ton = 2,000 pounds. The total discharges for all estimated exploration and delineation wells are given in Table B-2 of the DEIS.

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. We assume 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 2-28 of the Multiple Sale DEIS. All of the more expensive synthetic drilling fluids are assumed to be reconditioned and not discharged. In any case, all fluid discharges are regulated by several Federal and State agencies so as not to have adverse environmental consequences.

2.4.4.3. Development Activities.
Beaufort Sea: For a typical OCS sale in the Beaufort Sea, we assume the discovery/development of three oil fields with a combined size of 500 MMbbl (see Table B-2). Alternately, this scenario could be represented as 3,000 Bcf of gas. These oil or gas fields could be located anywhere in the program area, but it is more likely that the fields would be located near existing infrastructure and in relatively shallow water. In some cases, the fields could be developed as satellite pools drilled from existing facilities (Liberty is an example). Other fields could require a new offshore platform if drilling technologies cannot successfully exploit the reservoir from existing developments. Generally, the smaller fields would have shorter subsea pipelines through shallow water. Large fields are more likely to be discovered in more remote parts of the program area and could be in deeper water. Remote locations in the Beaufort OCS have been less explored and are more likely to hold large untested prospects. Larger area fields could use subsea wells to tap the distal portions of the pools, and subsea wells would be "tied back" to a central production platform. Large, remote fields would tend to have longer, larger diameter offshore pipelines, a new coastal facility, and new onshore pipeline segments to connect to the existing North Slope gathering system.

The development scenario optimistically assumes a discovery would be made. The scenario assumes that three new fields, ranging in size from 125-250 MMbbl, will be discovered. Production from these three hypothetical fields could peak at approximately 152,000 bbl/day in 2025 and last until 2038. Abandonment operations would last 2 years for each development project. The offshore fields would be developed using one production platform each, but the larger (250 MMbbl) field also could employ subsea wells to recover oil from the outer edge of the pool. A production platform in shallow water (<15 m [50 ft]) could be artificial gravel islands, whereas platforms in water depths of 10-50 m (33-164 ft) could be bottom founded and designed to withstand pack-ice conditions. For deeper water sites (>50 m), subsea wells could be tied back to the main production platform in shallower water. Using current technology, it is feasible to tie back 3-phase oil flowlines to the main platform over distances up to approximately 20 mi. Tie-back distances for subsea gas flowlines could be up to approximately 80 mi.

Production wells include a mix of near-vertical and laterally extended wells drilled from the platform. The average reservoir depth is assumed to be 10,000 ft, and the drilled depth of production wells is assumed to be 13,000 ft. We also assume that one-third of the total wells drilled in an oil field will be service wells (ratio of producer to injection wells is 2:1). Injection wells are used to dispose of wastes in the subsurface and for secondary and tertiary recovery strategies (pressure maintenance; reservoir sweep by fluids). Gas fields are developed with fewer wells, because well-drainage areas are wider and fewer waste injection wells are needed. For comparison, a reservoir with oil that required 30 wells (20 oil wells plus 10 injections wells) might only require 6 wells (5 gas wells plus 1 injection well) if it was a gas pool. A typical 13,000-ft production well would use approximately 860 tons of drilling mud and produce approximately 1,200 tons of rock cuttings. We assume that 80% of the drilling mud will be recycled during the multiple-well program, so 172 tons per well will be waste product. Spent drilling mud, rock cuttings, and formation water will be treated and then disposed of in the subsurface through injection wells. In some cases, drilling wastes could be transported off site to facilities for treatment and subsurface disposal.

The route selection and installation of offshore pipelines will take 1-2 years and could occur either in the summer open-water season or during winter when the landfast ice has stabilized. New onshore pipeline sections will take 1 year to complete with construction activities taking place simultaneously with the offshore pipeline installation. We assume that offshore pipelines will be trenched as a protective measure against damage by ice in all water depths less than (<) 50 m (164 ft). At the coastal landfall, pipelines may be elevated on short gravel causeways to protect them from shoreline erosion. Onshore oil pipelines will be elevated at least 2 m on vertical support members. Onshore gas pipelines often will be buried because they are more efficient to operate when chilled.

Because there is existing infrastructure on the North Slope, new offshore projects will use processing facilities and pipeline systems wherever possible. New onshore pipelines will be required to reach the existing gathering system. Pump (or compression) stations at the landfall will be required 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 well 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. Onshore pipeline sections will take 2-4 years to complete, with construction activities taking place simultaneously with the offshore pipeline installation. For onshore pipelines, typically both oil and gas pipelines would be elevated on supports, but large-diameter gas pipelines would be buried in the same corridor.

The MMS 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 (DEIS, Table 4.4.1.6.2-1). Onshore developments would originate at a pipeline landfall, the location of which is unknown. The pipeline and associated developments conceivably would then be the shortest, most cost-effective route to connect with pre-existing support infrastructure.

As a pipeline is expected to be placed on elevated structures or, less frequently, buried near, but not immediately adjacent to, the 19.8-m-wide (65-ft-wide) road, the pipeline "footprint" was integrated with the road footprint into a 0.03 km-wide (100-ft-wide) road/pipeline development "corridor." The road/pipeline corridor was assumed to be 80 km (50 mi) long. The shore base and staging facilities were assumed to each have gravel footprints of 0.2 km^2 (50 acres). 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 km^2 (40 acres). A new airstrip, if needed, is estimated to be 100 ft wide by 5,000 ft long.

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 USDOI, BLM and MMS, 2003, presently undeveloped) or existing gravel pits would be used or expanded for material to construct the development facilities. Overall, these developments are estimated to have a footprint of 3.45 km^2 (855 acres).

<u>Chukchi Sea:</u> When a large oil or gas discovery is made and defined by delineation wells, several project designs will be considered as alternatives. Because we have no knowledge of the site-specific conditions, we can offer only a general description of a possible future project 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 (mostly deeper than 100 ft) and affected by ice movements most of the year, a large bottom-founded platform is likely 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 pool, 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 inches 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. Gas production also will be gathered to the central platform for treatment. 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 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.

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 10 inches or smaller in diameter to carry up to 45,000 bbl/day and could be up to 20 mi long. Gathering lines from satellite platforms could be 12-18 inches in diameter to carry up to 150,000 bbl/day and could be up to 50 mi long. The main oil pipeline to the landfall will be 20 inches in diameter or larger to handle production rates ranging up to 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 as those assumed for oil, but gas is a lower density substance and BOE volumes will be lower. Gas flowlines (up to 10 inches) could carry about 70 MMcf per day; gathering lines (up to 18 inches) will carry about 480 MMcf/day; the main lines (>20 inches) would carry over 600 MMcf/day.

At the coast, a new facility will be constructed to support the offshore operations and will also serve as the first pump station for the overland pipeline. A likely location for the shore base would be between Icy Cape and Point Belcher, near Wainwright. The overland pipelines to the Prudhoe Bay area (TAPS and possible new gas pipeline), or a nearer gathering point will require coordination by BLM and oil field operators in the NPR-A. In contrast to offshore pipelines, new onshore pipelines will be installed during winter months. Various oil pipeline and communication lines will be installed on vertical supports above the tundra in a corridor stretching eastward up to 300 mi to connect to the North Slope gathering system. A chilled, high-pressure gas pipeline could be buried along the same corridor. Pump (or compression) stations required along the onshore corridor are likely to be collocated with fields. The overland oil pipeline is likely to be 24-36 inches in diameter to handle flow rates >300,000 bbl/day. We assume that the 48-inch TAPS pipeline will transport oil from the North Slope to the Port of Valdez. The product would then be tinkered to refineries on the west coast. A large overland gas pipeline (perhaps carrying 1 Bcf/day) would be 24-26 inches. Condensate liquids entrained in this 1 Bcf/day dense-phase pipeline would amount to 25,000 bbl/day.

An approximate timeframe for the scenarios is given in Tables B-6 of the DEIS. The time from leasing to production startup is expected to be 10-15 years. After discovery, delineation drilling and project feasibility studies may take several years followed by permitting for proposed development activities. When the project is approved, the design, fabrication, and installation of the facilities take another 4-5 years. Offshore and onshore pipeline permitting and construction would occur simultaneously (albeit in different seasons; open water versus winter) with the overall offshore work. Drilling of subsea wells could start before platform installation to allow a quicker ramp up of production. A new shore base would be constructed to support the first (anchor) field and then serve as the pipeline landfall.

The MMS can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production, but it was estimated in the Sale 193 final EIS (USDOI, MMS, 2007d) and remains current:

> As a pipeline is expected to be placed on elevated structures or, less frequently, buried near, but not immediately adjacent to, the 19.8-meter-wide (65-foot-wide) road, the pipeline "footprint" was integrated with the road footprint into a 0.03 km-wide (100-foot-wide) road/pipeline development "corridor". The road/pipeline corridor was assumed to be 482.8 km (300 miles) long. Consequently, direct impacts from pipeline/road construction are estimated to affect 14.72 km^2 (3,636 ac) of eider nesting habitat [see Table 4.5.1.6.2-1 of the DEIS].
>
> The shore base and staging facilities were assumed to each have gravel footprints of 0.2 km^2 (50 ac.). 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 km^2 (395 ac 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 to construct the development facilities.

2.4.4.4. Production Activities.

Production from the Beaufort Sea OCS

The total lifecycle (exploration through production activities) is estimated to be approximately 30-40 years, assuming an accelerated pace of discovery and development. Considering the typical field sizes assumed in the scenario, oil production could last 15-25 years for individual fields. Field life could be extended if the platform and wells are used for gas production after oil reserves are depleted. Later gas production 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, we do not expect significant gas sales from the Beaufort OCS until after 2018.

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 (pigs). Crew changes usually are at weekly intervals.

Production from the Chukchi Sea OCS

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. When the oil resources are depleted, the platform and wells could be used for gas production, if a gas-export system is built from the North Slope. This could extend field life another 20 years. However, the earliest that a gas-export pipeline could be operational is approximately 2018, with 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 2028.

Once the 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 (pigs). Crew changes usually are at weekly intervals.

2.4.4.5. Transportation Activities.

Transportation from the Beaufort Sea

Operations at remote locations in the Beaufort Sea would require transportation of materials, supplies, and personnel by different means, depending on seasonal constraints and phase of the operations. During past exploration seismic surveys, the vessels have been largely self-contained, so there were no helicopter flights to transport personnel, seismic data, and light supplies. Indications are that an industry vessel may have the capability to periodically transport personnel, seismic data, and light supplies to the mainland via helicopter at an interval of about once every six weeks (less than an average of one flight/day, not including any search and rescue operations). As previously discussed, seismic operations would be about 30 days in the summer open-water season. We assume that the smaller support vessel would make occasional trips (1 trip every 2 weeks) to refuel and resupply (probably at West Dock).

During exploration drilling, operations would be supported by both helicopters and supply vessels. Helicopters probably would fly from Prudhoe-area base camps at a frequency of one to three flights per day. Support-vessel traffic would be one to three trips per week, also out of the Prudhoe area (West Dock).

To support operations in remote parts of the Beaufort 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. 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 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. During production operations, aircraft generally would be smaller with less-frequent flights (2 per day). Ice-road traffic would be intermittent during the winter months.

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. 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. Assuming that barges will be used to transport drilling cutting and spent mud from subsea wells to an onshore disposal facility, we estimate 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 existing 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 double-hull 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, and eventually to U.S. markets.

Transportation from the Chukchi Sea

Operations at remote locations in the Chukchi lease-sale area would require transportation of materials, supplies, and personnel by different means, depending on seasonal constraints and phase of the operations. The general assumptions discussed in this section can be integrated with the scenario schedules provided to determine the full extent of transportation activities.

During past exploration seismic surveys, the vessels have been largely self-contained, so there were no helicopter flights to transport personnel, seismic data, and light supplies. Indications are that an industry vessel may have the capability to periodically transport personnel, seismic data, and light 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 throughout the entire open-water season (e.g., July-Oct.); 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. We assume that the smaller support vessel(s) would make occasional trips (1 trip every 2 weeks) to refuel and resupply from several possible locations (e.g., Kotzebue, Barrow, or West Dock).

During exploration drilling, operations would be supported by both helicopters and supply vessels. Helicopters probably would fly from Barrow at a frequency of one to three flights per day. Support-vessel traffic would be one to three trips per week, also out of Barrow. For exploration drilling operations that occur after a new shore base is established near Point Belcher, both helicopter and vessel traffic would be out of either Barrow or the new shore base. Therefore, an exploration staging area to support exploration operations will exist followed, if development occurs, by a new shore base, but not necessarily in the same footprint.

Construction of a new shore base 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. 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). Ice-road traffic would be intermittent during the winter months.

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 of the new shore base. 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-Nov.) 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, we estimate 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 6 years for each development requiring subsea wells.

2.4.5.6. Decommissioning Activities. 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 a pool is recovered. Typically, only 20-50% of the original oil in place is recovered (Prudhoe Bay is an exception that will recover over 60%). 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 (with cement) and wellhead equipment removed. Processing modules will be 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 more 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 (multibillion dollars), it is unlikely that complete abandonment would be a cost-effective alternative.

2.4.6. Ancillary Activities. Ancillary activities are those necessary oil and gas activities conducted by a leaseholder on MMS-issued leases for the purposes of obtaining data and information for their Exploration Plan (EP) or Development and Production Plan (DPP) (30 CFR Part 250, *Oil and Gas and Sulphur Operations in the Outer Continental Shelf, Subpart B-Plans and Information*, 72 *FR* 18577 § 250.105 Definitions). 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 MMS 30 calendar days in advance of and receive authorization from MMS before commencing ancillary activities.

2.4.6.1. Description of Ancillary Activities. This section describes the various ancillary activities-related techniques likely used by operators in the Beaufort and Chukchi seas OCS. The descriptions are not intended to be a comprehensive analysis of all techniques; instead, we provide fundamental details of various techniques and methods. Such details serve as a basis for assessing the environmental impact of these operations (i.e., identification of impact-producing factors or agents, determination of impact level; see Chapter 4, Environmental Consequences). Particular attention is paid to seismic techniques and especially the role of seismic sources (e.g., airguns), as this issue was identified during the scoping process as an environmental concern.

Ancillary activities include (30 CFR §250.207):

- geological and geophysical (G&G) exploration and development G&G activities;
    - G&G explorations are surveys on a lease that use seismic reflection, seismic refraction, magnetic, 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.

The MMS requires complete site-clearance and shallow-hazards surveys prior to drilling exploration wells (30 CFR §250.214). Shallow-hazards and site-clearance surveys involve geophysical data collection and interpretation to identify and characterize any potentially hazardous conditions at or below the seafloor. They also identify potential benthic biological communities (or habitats) and archaeological resources in support of review and mitigation measures for OCS exploration and development plans. 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 safely completed.

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

High-resolution systems provide an image of the seafloor and below-seafloor conditions without physical disturbance of the seafloor. A typical high-resolution seismic survey operation consists of a ship towing an airgun and a streamer cable with a tail buoy. The ship travels at 3-3.5 knots and the airgun fires every 12.5 meters (or about every 7-8 seconds). Surveys usually cover one lease block, which is 4.8 kilometers on a side. A ship steams in one direction for about an hour, then turns around and surveys the next track. Other acoustic sound sources used in high-resolution seismic profiling include “chirp” and “boomer” systems. Mitigation and other measures for seismic surveys are presented in Appendix K of the DEIS.

Vertical seismic-profile surveys correlate geologic data to seismic data. Receivers on vertical cables are lowered into a borehole by a crane suspended from a rig. A single workboat fires an airgun/airgun array, and the receivers pick up the generated sound.

Other methods used to conduct ancillary activities include deep-tow side-scan surveys, electromagnetic surveys, remote-sensing surveys, and geological/geochemical sampling.

Side-scan sonar is a sideward-looking, two-channel, narrow-beam instrument that emits a sound pulse and listens for its return. The sound energy transmitted is in the shape of a cone that sweeps the seafloor. 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.

Electromagnetic surveys do not induce electrical currents into the earth but instead, a receiver device detects the natural electrical and magnetic fields present in the earth. 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.

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 surface sediments.

2.4.6.2. Potential Effect-Producing Factors Associated with Ancillary Activities. The potential impact-producing factors associated with ancillary activities are associated with other OCS activities. Disturbances from ancillary activities on the marine environment may occur from noise, vessel and air traffic, and bottom disturbance. Noise would be generated from ship-borne electronic equipment and routine operations and activities. Vessel and air traffic potentially could disturb wildlife. Bottom sampling would disturb marine sediments and bottom-dwelling organisms. However, the potential effects of ancillary activities are expected to be small, short term and localized.

3. DESCRIPTION OF THE EXISTING ENVIRONMENT

Section 3.1 briefly describes the existing infrastructure and transportation on the North Slope and adjacent marine areas. There are two general components: those elements that primarily support the oil and gas industry and those that do not. We describe the present status and trends in infrastructure in Section 3.1.2. Transportation (Section 3.1.3) activities across the North Slope -- aircraft and vessels that support the oil and gas industry as well as coastal communities and other activities on the North Slope and in adjacent marine areas -- are described in Section 3.1.3.

3.1. Oil and Gas Development and Production, Existing Infrastructure, and Transportation Systems.

3.1.1. Oil and Gas Development and Production on the North Slope.

Although some oil and gas activities on the North Slope have now waned, present-day activities that are expected to occur within the next few years are considered in this section.

3.1.1.1. Past Oil and Gas Development and Production. Oil and gas activities have been the main agent of industrial-related change on the Alaska North Slope following the decline of commercial whaling in the 20th century. Extensive oil and gas exploration activities have occurred on the North Slope since the 1940s, and large-scale development began in the 1970s with the Prudhoe Bay field.

Exploration activities moved offshore into the Beaufort and Chukchi seas in the 1970s, and development and production in the nearshore Beaufort Sea began in the early 1980s. Thirty-five fields and satellites have been developed on the North Slope and nearshore areas of the Beaufort Sea and are producing oil (see Table 3.1.1-1). The center of industrial development was around the Prudhoe Bay field and included the creation of an industry-support community and airfield at Deadhorse, with an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks. In 1977, the Trans-Alaska Pipeline System (TAPS) was completed to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska, and it continues operation today. Full-scale oil production peaked in 1988, carrying nearly 2.1 million barrels (MMbbl) per day. Since then, new development has not entirely replaced declining oil production from older fields. Although TAPS has capacity for more oil (now transporting approximately 707,000 barrels [bbl] per day [Alyeska Pipeline, 2008]), most of the production facilities on the North Slope are operating at maximum capacity for water and gas handling (Kaltenbach et al., 2004). In November 2002, the TAPS right-of-way was renewed for another 30 years by both State and Federal agencies.

Existing oil and gas projects include those already in production and those where production is expected within 6 months. Three existing projects are located offshore in the State waters of the Beaufort Sea (Endicott, Northstar, and Oooguruk), and they also have satellite pools (Sag Delta, Sag Delta North, Eider). Northstar, covered by both State and Federal outer continental shelf (OCS) leases, began producing in October 2001. The Point McIntyre and Niakuk pools are located mostly offshore but the production facility (wells and pipeline) are onshore and, therefore, they are listed as “onshore” fields. Endicott is an offshore State field that began production in 1987 and, through 2007, had produced 477 MMbbl of oil. Oooguruk is a production facility that began production in June 2008 (Pioneer Natural Resources, 2008). The facility is located 5 miles (mi) (8 kilometers [km]) offshore in around 5 feet (ft) (1.5 meters [m]) of water adjacent to the Colville Delta. After 30 years of leasing in the Alaska OCS, there are no commercial oil or gas facilities located on Federal OCS lands. As a result of nearly 30 years of leasing and exploration activities, three production facilities have been installed offshore in the Beaufort Sea. The Endicott field was the first offshore facility in State waters (2 mi offshore), and artificial gravel-production islands are connected to shore by a causeway. The Northstar field was the second offshore facility and produces a small amount of oil from OCS tracts, approximately 18% of the

208 MMbbl field, by wells drilled from a gravel island in State waters (5 mi offshore). In June 2008, the fourth production facility, the Oooguruk field, was in development stage and will produce oil from an artificial gravel island located 3 mi offshore in 5 ft of water. Plans for development of the OCS Liberty field include ultra-extended-reach wells drilled from the Endicott satellite drilling island.

3.1.1.2. Present Development and Production. Present development and production includes fields that are in stages of development (permitting or construction), and production is expected within a few years (Table 3.1.1-1). British Petroleum has proposed an ultra-extended-reach drilling project from the South Drilling Island (SDI) to develop the Liberty Prospect, with eventual production making use of existing production infrastructure from the Endicott Facility (USDOI, MMS, 2007a). The CD-5 is an onshore field on State leases and will be developed on gravel pads. Nikaitchuq is a mixture of onshore and offshore facilities in State waters. Current reserve estimates total about 160 MMbbl for these three fields (Table 3.1.1-2), although the estimates are somewhat uncertain at the predevelopment stage. Infrastructure components, scheduling, and reserve estimates are fairly well defined, but reserve volumes could be revised. These new developments are tied into existing infrastructure as satellites, and they depend on the nearby infrastructure to be viable.

The State develops and approves an oil- and gas-leasing plan for a 10-year period, reassesses the plan, and publishes a schedule every other year (see Table 3.1.1-3). Except for Northstar, all of the North Slope and Beaufort Sea's commercially producing oil fields are on State leases. The production though 2007 from State and Federal (Northstar) leases totals 15.4 billion barrels (Bbbl) (Table 3.1.1-4), and approximately 61 trillion cubic feet (Tcf) of natural gas has been cycled through facilities. All of this gas production has been used as fuel for facilities or has been reinjected to increase oil production.

3.1.1.2. Assumptions, Scenarios, and Activities associated with the Proposed Action

3.1.1.2.1. Oil and Gas Development and Production on State Lands. Since the first State North Slope lease sale (Sale 13) in December 1964, the State of Alaska has held 56 oil and gas lease sales involving North Slope and Beaufort Sea leases. More than 11.5 million acres in 3,065 tracts have been leased. Some of the tracts have been leased more than once, because the leases expired or were relinquished. Historically, only about half of the tracts offered in State oil and gas lease sales have been leased. Of the leased tracts, 407 or about 13% were drilled and only 292 tracts, or about 10% of those leased, have been commercially developed (Decker, Silliphant, and Krouskop, 2008). About 81% of the State-leased acreage was onshore, and about 19% was offshore (State of Alaska, Dept. of Natural Resources [ADNR], Division of Oil and Gas, 2007a). In the 64 years from 1944 through 2007, 496 exploration wells were drilled on the North Slope (Banks, 2008; Silliphant, 20008, pers. commun.; includes Federal lands onshore). During this period, the number of exploration wells drilled annually has ranged from 0-35. From 2004 through 2007, in a time of climbing oil prices, the number of exploration wells drilled annually has ranged from 9-15, averaging 12 per year and within historical ranges. Sixty of the 496 exploration wells resulted in discoveries, representing a "geological" success ratio of about 12%. Thirty-two of these discoveries have been commercially developed, representing an "economic" success ratio of about 7% (ADNR, Division of Oil and Gas, 2007b).

3.1.1.2.2. Gas Development and Production on the North Slope. Approximately 6 billion cubic feet (Bcf) of natural gas is handled per day by North Slope facilities. Large amounts of natural gas have been discovered during exploration on the North Slope, much of which is associated with oil. Since the mid-1970s, numerous conceptual strategies have been offered to move natural gas from the North Slope to market. However, proven gas resources of approximately 35 Tcf and undiscovered gas resources of approximately 200 Tcf exist. There is no existing system for natural gas to be transported from the North Slope to market, and all gas associated with oil production is used as fuel for facilities or reinjected to increase oil recovery.

3.1.1.2.3. Federal Lease-Sale History in the Beaufort Sea. Various portions of the current sale area were offered in 10 previous lease sales (Map 3.1.1-1) (Sales BF, 71, 87, 97, 124, 144, 170, 186, 195, and 202 from 1979-2006). As of November 1, 2008, there are 281 active leases on Federal submerged lands in the Beaufort Sea, including portions of several discoveries that are potentially producible (Figure 3.1.1-1). However, there are no publicly available estimates of proven resources in these prospects. The Northstar Unit includes three Federal tracts that contain 15-20% of Northstar's estimated 158 MMbbl of oil reserves. Approximately 20% of the total undiscovered conventionally recoverable oil resources in the Beaufort Sea are estimated to occur under existing OCS leases. The remaining undiscovered resources (80%) represent an attractive target for future exploration. However, as in other remote areas in northern Alaska, commercial development faces difficult technical, economic, and political challenges and will require sustained oil prices above $25 per barrel.

3.1.1.2.4. Federal Lease-Sale History in the Chukchi Sea. The Chukchi Sea area was once divided into two planning areas, the northern portion as part of the Beaufort Sea Planning Area and the remaining part being in the current Chukchi Sea Planning Area. Portions of the current area were offered in four previous lease sales (Map 3.1.1-2) Sales 97 and 109 in 1988, and Sales 124 and 126 in 1991). A total of 483 tracts were leased in these four sales (approximately 2.7 million acres) and attracted $512 million in total high bids. Exploration associated with these lease sales included approximately 100,000 line-miles of 2-dimensional (2D) seismic data, with nearly three-quarters of the total line miles acquired between 1980 and 1989. As shown on (Map. 3.1.1-2), five large prospects were drilled (Burger, Klondike, Crackerjack, Popcorn, and Diamond) between 1989 and 1991. Although most of the five Chukchi shelf wells encountered favorable geology, none discovered commercial quantities of oil or gas, and exploration of the Chukchi shelf was discontinued. Through successive rounds of relinquishments, industry lease holdings gradually diminished and none of the 483 leases on the Chukchi shelf in 1992 remain active.

Lease Sale 193 was held in February 2008. A total of 487 blocks were leased. These leased blocks are scattered across the Chukchi Sea Planning Area, with the closest to land being approximately 54 mi offshore (Map 3.1.1-2).

3.1.1.3. Oil-Production Spill History. Impacts associated with oil development have occurred over the past 3 decades, and there are data from monitoring that accurately reflect some of the long-term effects (National Research Council [NRC], 2003a).

Table 3.1.1-4 lists 2007 production and reserve data through year-end 2007. Additional discussion of the history of North Slope development and listing of infrastructure components is given in U.S. Department of the Interior (USDOI), Bureau of Land Management (BLM) (2005b: Section 4.7.1.1 and Table 4-33).

3.1.1.3.1. Oil and Hazardous Material Spills. Oil or hazardous material spills have occurred in marine and terrestrial environments of the North Slope. While spills in terrestrial areas by far are more numerous, they tend to be more easily contained and have fewer perceived impacts than spills in marine areas. Spills in marine areas could spread quickly in or to areas supporting concentrations of sensitive resources.

Two documented large diesel-fuel spills have occurred in the Beaufort Sea, one of 2,440 bbl on September 18, 1985, from a diesel tank on an eroded gravel island in the Canadian Beaufort Sea, and the other of approximately 1,600 bbl on August 21, 1988, from a punctured Crowley barge delivering fuel to Kaktovik (http://www.incidentnews.gov/incident/6606). In both spills, responders could not find remains of the spill after 3 days. Exploration on Arctic OCS leases resulted in 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.

According to the State of Alaska, Department of Environmental Conservation (ADEC, 2007a), there were 4,481 spills of seawater, produced water, crude oil, diesel, and drilling muds on the Alaska North Slope Subarea between 1995 and 2005, for a total volume of approximately 45,000 bbl. More than half of the spills were less than (<) 10 gal, and 98% of the volume released resulted from spills greater than (>) 99 gal. Oil exploration and production facilities were responsible for more than 90% of the spills and approximately 90% of the volume. Thirteen diesel-fuel spills equal to or greater than (≥) 24-2,391 bbl occurred in villages of the North Slope Subarea over the last 20 years. The ADEC (2007a) also reported that the highest probability of spills of non-crude products occurs during fuel-transfer operations at the remote villages of the North Slope Subarea.

Ongoing increases in cruise-ship traffic in polar seas has generated particular concern, because some of these vessels appeared ill suited to operate in such potentially adverse, often inherently dangerous, conditions away from adequate search and rescue cover. The loss of the Liberian-flagged P/V *Explorer*, which sank in the Antarctic Ocean, was the most well known of a series of recent cruise-ship incidents in polar seas. There were at least three other incidents in 2007. The R/V *Aleksey Maryshev* ventured so close to an ice shelf, that ice fell onto the deck, injuring passengers. The M/S *Nordkapp* grounded on a submerged Antarctic caldera in January, damaging the hull and leaking fuel into the marine environment (Associated Press, 2007a). A Norwegian cruise vessel, the M/S *Fram*, lost power in late December 2007 and struck an iceberg (Associated Press, 2007b).

It is unclear how many of these tourism vessels are ice strengthened, but it is known that some were not. Having an ice-strengthened hull, however, did not save the P/V *Explorer* when it was holed in the side by ice and sank. While all of the passengers were safely rescued, the vessel and its contents, including 40,000 gal of diesel oil, now lay 4,900 ft at the bottom of the ocean (Haaba, 2007). Nearby countries expressed concern that this oil may slowly leak from this wreck, creating chronic slicks that will impact the surrounding marine ecosystem for decades. While some coastal communities have embraced this form of tourism because of economic benefits of land-based passenger activities, increasing ship-based tourism has increased the serious risk that marine accidents could harm coastal resources.

3.1.1.3.2. Context of Oil Spills. Oil spills occur from exploration and production activities. It is important to put in context the contribution oil spills from exploration and production activities in relation to other sources. In North America, the exploration and production industry contributes approximately 2% of petroleum to the coastal waters of North America. The MMS estimates that the OCS exploration and production industry spills approximately 1 bbl for every 156,900 bbl produced on the OCS. For the Alaska North Slope, the estimate is approximately 1 bbl for every 600,000 bbl produced.

The NRC (2003, *Oil in the Sea*) examined reports from a variety of sources, including industry, government, and academic sources, and concluded that although the sources of petroleum input to the sea are diverse, they can be categorized effectively into four major groups: natural seeps, petroleum extraction, petroleum transportation, and petroleum consumption. Natural seepage of crude oil from geologic formations represents over 60% of the petroleum entering the marine environment off North America. The seepage of crude oil to the marine environment tends to occur sporadically and at rates low enough that the surrounding ecosystem can adapt. Petroleum extraction activities introduce, on average, 3% of all the anthropogenic (~2% of all inputs) petroleum introduced into coastal waters of North America. Petroleum transportation (including refining and distribution activities) of crude oil or refined products results in the release of roughly 9% of all the anthropogenic (~4% of all inputs) petroleum introduced into coastal waters of North America. Releases that occur during the consumption of petroleum, whether by individual car and boat owners, non-tank vessels, or runoff from increasingly paved urban areas, contribute the vast majority of petroleum released into North American waters, roughly 85% of all the anthropogenic (~33% of all inputs) petroleum introduced into coastal waters (NRC, 2003b).

Since 1990, projected domestic oil-field production has declined, while oil consumption has increased. This growing shortfall indicates that production-related petroleum releases, as a percent of all anthropogenic sources, have been decreasing, while those inputs from petroleum consumption have been increasing. Significant increases in land-based runoff of petroleum hydrocarbons can be expected as a byproduct of this increased consumption—there is more petroleum reaching North American coastal waters from consumption activities and less from petroleum-production activities.

As domestic production continues to decline, more crude and refined products are imported from other sources and petroleum inputs from the petroleum-transportation sector increases, especially near oil-transfer facilities (NRC, 2003). As greater amounts of oil will be transported by vessel, refineries will have to increase capacity, and more coastal handling facilities will be needed. These have the potential to increase the input of hydrocarbons into the oceans. However, the operational and accidental discharge of oil from vessels and platforms has declined substantially over the past 3 decades, and it is reasonable to expect continued improvement in these areas in future years, as the benefits from recently enacted regulations and improved operational practices are fully realized (NRC, 2003b).

A review of OCS spill data for petroleum spills of ≥1 bbl for the years 1971-2007 shows the spill record has improved over time. Between 1971 and 2007, OCS operators have produced almost 15 Bbbl of oil. During this period, there were 2,645 spills, which 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. 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, which 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.).

3.1.2. Infrastructure.

Individual oil pools have been developed together as fields that share common wells, production pads, and pipelines. Over time, fields also have been grouped into production units with common infrastructure, such as processing facilities.

3.1.2.1. Oil-Industry Infrastructure. According to USDOI, BLM (2007), oil and gas activities have resulted in the development of 500 acres of peat roads, 9,000 acres of gravel roads and pads, 6,000 acres of gravel mines, and 2,000 acres of other facilities on the North Slope. These add up to approximately 17,500 acres of direct impacts to soil that persist today. Few of these acres have been restored to their original condition. Secondary or indirect effects (primarily changes in the hydrologic regime) are believed to affect another 17,500 acres.

Recent technologies, including horizontal drilling, closer spacing of wells on pads, and a slowing of oil-field development, have greatly reduced the amount of surface disturbance needed to develop and produce oil. As a result, the annual amount of surface disturbance associated with gravel roads and pads has slowed substantially during the past 2 decades (USDOI, BLM, 2007). Some recent developments initially are proposed without a gravel road connection to the Prudhoe Bay-Kuparuk infrastructure, but these connections often are constructed later.

Oil companies have reported that warming arctic temperatures make the operation of oil-field compressors less efficient and reduce oil production. Unstable permafrost could affect undersea pipelines; sea level rise could compromise the effectiveness of gravel-production islands and submerged barrier islands that afford protection to nearshore production sites; an increase in storm severity combined with longer periods of broken ice also could increase the threats to these facilities and add difficulty to oil-spill cleanup.

3.1.2.2. Community Infrastructure. Coastal communities vary in size but typically have many of the same types of infrastructure. These structures and facilities include an airstrip, a landfill, and a variety of buildings and dwellings. The USDOI, BLM (2007) estimated that village facilities have directly impacted approximately 1,800 acres across the North Slope.

While some communities receive natural gas from nearby production facilities, all generate their own electricity, and some have elevated power lines to distribute electricity. Many residences operate on fuel oil delivered in bulk during the open-water season.

3.1.3. Transportation.

3.1.3.1. Aircraft Traffic. At least three airline companies provide passenger service to North Slope communities. ConocoPhillips and BP Exploration (Alaska), Inc. (BPXA) use a private jet company, Shared Services, Inc. At least four different companies move cargo between North Slope communities and Anchorage and Fairbanks in Alaska and Yellowknife in Canada. The majority of intercommunity travel and freight hauling on the North Slope typically is with commuter-type aircraft operated by a number of smaller carriers. Industry uses helicopters to support routine activities such as seismic surveys, crew changes at offshore sites, and to resupply remote camps/facilities. Government and university researchers sometimes charter aircraft for research projects.

3.1.3.2. Vessel Traffic. Two forms of vessel traffic are common during the Arctic Ocean open-water season. Local skiffs typically are smaller vessels used for hunting and between-village transportation during the open-water period. The Beaufort and Chukchi seas, unlike other OCS areas in the United States, do not support an extensive maritime industry transporting goods between major ports. However, during ice-free months (June to Oct.), barges are used for supplying the local communities, Alaskan Native villages, and the North Slope oil-industry complex at Prudhoe Bay with larger items that cannot be flown in on regular commercial air carriers. Barge-transported commodities include diesel fuel for electric power generation, gasoline and other petroleum products, raw materials, and manufactured goods. Usually, one large fuel barge and one supply barge visit the villages per year and one barge per year traverses through the Arctic Ocean to the Canadian Beaufort Sea.

Existing oil-field developments on the North Slope are serviced by land, air, and sea. Tug and barge traffic associated with the onshore oil development travel mainly in nearshore waters along the coast. Major sealifts into the industrial complex at Prudhoe Bay occur frequently. Between 1968 and 1990, approximately 480 sealifts (averaging 22 per year) were made to Prudhoe Bay, which corresponds to the time period when the complex was constructed and subsequently expanded. Since then, approximately 40 sealifts have been made to Prudhoe Bay (averaging 2-3 per year); however, in many years, no sealift occurred. Service vessels that support various requirements of offshore oil and gas activities are categorized into supply, crew, and utility vessels, each of which produce noise above and under water; discharges; and air emissions. Service-vessel trips usually are greatest during exploration, drilling, and construction phases and are greatly reduced during the production phase. In 2006, Shell Offshore, Inc. proposed a 3-year exploratory drilling program on their Federal leases in the Beaufort Sea (USDOI, MMS, 2007b). This program was stayed by court order in 2007. Shell's proposed program would use several support vessels, including a dedicated spill-response vessel.

Alaska Clean Seas is a company that is contracted to respond quickly to spills on the North Slope and adjacent marine areas. This company periodically performs spill-response drills in marine areas to practice effective response strategies.

Numerous sources report recent increases in vessel traffic in the Arctic. The U.S. Coast Guard (USCG) anticipates a continued increase in vessel traffic in the Arctic. According to the USCG (2007), the primary source of distress calls in the Arctic are stranded whale hunters. For example, in July 2004, the USCG facilitated a search for four overdue hunters from Nuiqsut. The search used assets from the USCG Cutter *Healy* and HH-65 Dolphin helicopter, USCG Air Station Kodiak C-130s, the 210th Air National Guard Rescue Squadron, and King Air from the North Slope. The search covered more than 3,000 mi. The USCG helicopter located the four men on the beach in the Colville Delta, and they were returned to Nuiqsut. The cost of this rescue totaled more than $313,000. The USCG is considering possibilities for a seasonal forward operating base to decrease long-range rescue expenses (USCG, 2007).

In addition to vessel traffic that supports coastal communities and the North Slope oil industry, vessel traffic in the arctic seas is changing as the open-water season begins earlier and ends later and there is increased opportunity for shipping, research, and cruise-ship tourism. Shipping routes via the Northeast Passage have increased, as this route has opened on a more predictable basis. Similarly, there are numerous recent articles describing the economic benefits of a shipping route through the Northwest Passage made possible by decreasing ice distribution, saving at least 4,000 miles from a route through the Panama Canal. Research-vessel traffic to the Arctic has increased, as scientists are collecting climate change and resource information in areas previously inaccessible.

Changes in the distribution of sea ice and increasing interest in observing iconic wildlife and marine mammals may support an increase in adventure or luxury cruises in remote polar, especially Arctic, locations (http://www.alvoyages.com/arctic-cruises/). Some impacts from increasing cruise-ship traffic arise from these ships seeking opportunities for close-approach views of wildlife and marine mammals.

3.1.3.3. Snowmachine Traffic. The two principle sources of transportation activity on the North Slope are the oil industry and the Iñupiat communities. Industry generally is encouraged to conduct many onshore and nearshore operations in winter when feasible to protect delicate tundra and also to minimize environmental effects on nesting birds and terrestrial mammals. Commonly used industrial-support trails have developed over the course of industry activities. In addition, snowmachines are used for subsistence hunting and between-village transportation during winter. The use of snowmachines has extended subsistence hunting and other travel into areas not previously accessible from local villages without the use of spur camps. Snowmachine traffic commonly runs along many of the same routes each year, often following the coastline or major rivers (Tremont, 1987).

3.1.3.4. Ice-Road Construction. The oil industry builds ice roads in winter to access areas that otherwise would be inaccessible to large equipment. Freshwater from local streams and ponds is used to build a thick, flat road surface capable of supporting large machinery. Ice-road construction begins after freeze-up and after there is a minimum of 6 inches of base snow. Ice roads are built over tundra and shorefast ice to facilitate exploration and development while minimizing impacts (Tremont, 1987).

3.2. PHYSICAL ENVIRONMENT.

3.2.1. Geology.

3.2.1.1. Arctic Alaska Offshore Provinces - Petroleum Geology and Exploration History.

3.2.1.1.1. Geographic Setting of Arctic Offshore Planning Areas. The Beaufort Sea Planning Area extends from the 3-statute-mile (4.8 kilometers [km]) limit of State of Alaska waters northward to lat. 75° N. on the west (west of long. 148° W.) or to lat. 74° N. (east of long. 148° W.). The planning area extends from longitude 156º W. (roughly north of the village of Barrow) on the west to the Canadian maritime boundary, as shown in Figure 3.2.1-1. Water depths beneath the Beaufort Sea Planning Area range up to 3,800 m (12,467 ft), with the greatest depths achieved in the northwest corner of the planning area (bathymetry of Perry and Fleming, 1990).

The Beaufort Sea continental "shelf" consists of two steps. The inner step is the true shelf and extends from the coast north to the 50-m (164 ft) isobath. The outer step lies between the 150- and 500-m (492- to 1,640-ft) isobaths. The inner and outer steps are separated by a steep slope that lies between the 50- and 150-m (164- and 492-ft) isobaths. The inner shelf is the area generally targeted for petroleum exploration, and water depths there range from 10-50 m (33-164 ft).

The east boundary of the Chukchi Sea Planning Area adjoins the Beaufort Sea Planning Area along long. 156º W. Southwest of Barrow, the planning area boundary follows the 3-mi (4.8 km) offshore limit of State of Alaska waters. The west boundary of the planning area lies along long. 169° W. or the Russian maritime boundary. The planning area extends from lat. 68º20′ N. (near Point Hope) northward to lat. 75º N. Water depths within the Chukchi Sea Planning Area range up to 3,800 m (12,467 ft), with the greatest depths in the Canada basin beneath the northeast corner of the planning area. Water depths across most of the Chukchi shelf (within the 100-m [328-ft] isobath) typically are about 50 m (164 ft) except in the Barrow submarine canyon, where water depths range 80-200 m (262-656 ft).

3.2.1.1.2. Arctic Offshore Program Areas and Future Oil and Gas Leasing. The MMS 2007-2012 leasing program that was announced in April 2007 (USDOI, MMS, 2007c) initiated the process that could lead to lease sales within "program areas" in the Beaufort Sea and Chukchi Sea Planning Areas, as shown in Figure 3.2.1-2. The 2007-2012 5-Year Program includes proposed Beaufort Sea lease sales for 2009 (Sale 209) and 2011 (217). The program also includes proposed Chukchi Sea lease sales for years 2010 (212) and 2012 (221), contingent upon the public review process, favorable resolution of environmental issues, and final approval by the Secretary of the Interior.

3.2.1.1.3. Petroleum Potential of the Arctic Offshore Continental Shelves. The Beaufort and Chukchi shelves are in many ways direct geological extensions of the highly successful petroleum-producing area onshore, here termed the "Northern Alaska Province" (outlined in Figure 3.2.1-1). The Northern Alaska Province is endowed with original recoverable reserves of nearly 22,000 MMbbl of oil and 35 Tcf of gas in developed fields and undeveloped discoveries (Houseknecht and Bird, 2005: Table 1). As of the end of 2006, 15,300 MMbbl had been produced and exported out of the Northern Alaska Province through the 800-mi TAPS that connects the producing fields to the ice-free tanker port in southern Alaska at Valdez (see Figure 3.2.1-1). Most of this oil was delivered to markets on the U.S. west and Gulf coasts. Oil production from the Northern Alaska Province peaked in 1988 at approximately 2 MMbbl per day and, at that time, comprised 25% of U.S. oil production. By early 2007, oil production had fallen to 0.7 MMbbl per day, but yet comprises approximately 14% of U.S. oil production (Energy Information Agency, 2007).

The geologic elements that are critical to the creation of oil and gas fields include:

- rocks rich in organic matter that can be converted to oil and gas when heated in the course of deep burial, often the deepest parts of geologic basins;
- migration paths, usually through inclined permeable strata, that can carry oil and gas from deep generation areas upward to relatively shallow traps;
- sealed traps, usually located in areas of shallow burial near the margins of basins; and
- porous rocks, or "reservoirs", that offer abundant internal void space to store the petroleum within traps.

The absence of any of these key elements usually foretells the absence of commercial quantities of oil or gas in a basin. All of these key elements are widely present in the Northern Alaska Province and led to the creation of two of the largest oil fields in North America (Prudhoe Bay, 13,600 MMbbl; Kuparuk, 2,900 MMbbl). Because many of the key geologic characteristics of northern Alaska extend directly offshore into the numerous untested prospects beneath the arctic continental shelves, the latter are believed to offer high potential for future oil and gas discoveries.

The U.S. Geological Survey (USGS) has estimated that the Northern Alaska Province (onshore and State waters within 3 mi [4.8 km] of shore) contains mean undiscovered resources of 27.00 billion barrels (Bbbl) of oil and natural-gas liquids and 119.15 Tcf of natural gas (Houseknecht and Bird, 2005:Table 4). The MMS has estimated that the Beaufort Sea Planning Area offers mean undiscovered resources of 8.22 Bbbl of oil and natural gas liquids and 27.64 Tcf of natural gas (USDOI, MMS, 2006e). The same MMS study estimated that the Chukchi Sea Planning Area offers mean undiscovered resources of 15.38 Bbbl of oil and natural-gas liquids and 76.77 Tcf of natural gas. As summarized in Table 3.2.1-1, the Arctic offshore planning areas together capture a 47% share of the undiscovered oil and gas resources of the greater "Arctic Alaska petroleum province" (onshore and offshore combined).

3.2.1.1.4. Petroleum Potential of Deepwater Areas of the Arctic Offshore Planning Areas. The 500-m (1,640 ft) isobath was adopted in 1995 as a proxy for the present northern practical limit for petroleum development in the Beaufort Sea Planning Area (Sherwood, 1998:99). The 500-m (1,640 ft) isobath approximately corresponds to the transition from continental crust (of northern Alaska and the Beaufort shelf) to oceanic crust (of the Canada basin). North of this transition and west of longitude 146° W., the geology, as observed on a few reconnaissance seismic lines, appears to consist of undisturbed, flat-lying deepwater muds and silts that probably offer no porous reservoirs or trapping mechanisms for conventional oil and gas (Grantz et al., 1990:Figure 5). Seismic-reflection events that may mark gas (methane) hydrates are observed in this area in water depths between 400 and 2,800 m (1,312-9,186 ft) (Kvenvolden and Grantz, 1990:542). East of longitude 146° W. and north of the 1,000-m (3,281-ft) isobath, the Canada basin fill is contorted by folds (Grantz et al., 1990: Figure 4). These folds might form traps for petroleum, but it is doubtful that any porous reservoirs are present in the basinal strata deformed by the folds.

From a logistical standpoint, the extreme water depths, the presence of multiyear pack ice, and the steeply sloping seafloor beyond the 500-m (1,640-ft) isobath in the Beaufort Sea essentially preclude exploration and development using existing technologies. Permanent installations in areas of multiyear pack ice (i.e., both the Beaufort Sea and Chukchi Sea Planning Areas) are limited to water depths <100 m (328 ft), owing to constraints of ice-resistance engineering and foundation shear strength (Fitzpatrick and Paulin, 2007).

The parts of the Chukchi Sea Planning Area north of the 100-m (328-ft) isobath and west of Hanna submarine canyon (see Figure 3.2.1-2) extends over the deep basins and submarine ridges of the Chukchi borderland. The bathymetric highs and submarine ridges of the Chukchi borderland may have continental crust affinities, and the ridges apparently represent fragments of a continental margin that has been broken apart by rifting (Hall, 1990, and references therein). This continental margin may or may not have hosted a petroliferous basin. Shallow cores from one submarine ridge (Northwind) did not encounter petroleum but recovered Paleozoic and Mesozoic rocks equivalent to those found in a number of petroliferous basins that rim the Arctic Ocean (Grantz et al., 1998). To the east of Hanna canyon and north of the 500-m (1,640-ft) isobath, the Chukchi Sea Planning Area extends over the Beaufort slope and the Canada basin abyssal plain that lie outboard of the Beaufort shelf.

Because of (1) the unpromising or unknown petroleum geology and (2) the severe operating environment, all of the technically recoverable oil and gas resources of the Chukchi and Beaufort Sea Planning Areas are considered to be located on the continental shelf. The continental shelf area of petroleum potential lies south of the 100-m (328-ft) isobath (west of long. 162° W. or Hanna submarine canyon) or the 500-m (1,640 ft) isobath (east of long. 162° W.; USDOI, MMS, 2006e). This northern practical limit for petroleum development is mapped as the "shelf edge" in Figure 3.2.1-1 and as the isobaths representing the "Practical Limit for Petroleum Development" mapped in Figure 3.2.1-2.

3.2.1.1.5. Production History. Discovered resources in the arctic Alaska petroleum province are scattered among more than 50 oil and gas accumulations, but most commercial production comes from the Prudhoe Bay oil field and several nearby fields at the head of the TAPS oil pipeline (Figure 3.2.1-2). Prudhoe Bay field, with original oil reserves of 13,600 MMbbl, was discovered in 1967 and announced in 1968. The Prudhoe Bay discovery set off a period of energetic oil exploration that led to important additional discoveries. Prudhoe Bay and nearby oil fields sparked oil development in Arctic Alaska because they formed an asset base sufficiently large to justify construction of the 800-mi (1,287-km) long TAPS pipeline and the tanker port in Valdez.

Table 3.2.1-2 summarizes the remaining reserves, net production, and original oil and gas reserves associated with developed oil and gas fields of the North Slope. From first TAPS oil throughput in 1977 through December 2006, more than 15,300 MMbbl have flowed to the tanker port in Valdez, Alaska. This produced oil represents 75% of the original reserves (20,645 MMbbl) of the producing fields.

As of December, 2006, 61,897 Bcf of gas had been produced at the commercial oil fields near Prudhoe Bay. The produced gas represents 186% of the total original gas reserves of these oil fields—the gas reserves already have been produced nearly twice. Of the produced gas, most was reinjected to stimulate oil recovery, but 5,697 Bcf of the produced gas had been consumed to energize oil-development operations in the Prudhoe-area fields (Table 3.2.1-2). The consumed gas represents 17% of the original gas reserves of 33,206 Bcf (in the Prudhoe-area fields). This reserve volume does not include the 8,000 Bcf of gas estimated to occur in the undeveloped Point Thomson field.

The only Federal OCS production is at the 206-MMbbl Northstar field, which straddles State of Alaska and Federal OCS waters of the Beaufort Sea Planning Area (see Figure 3.2.1-2). As of December 2006, the Northstar field had produced 109 MMbbl, of which 19.4 MMbbl (17.84%) was extracted from the Federal OCS.

Table 3.2.1-3 summarizes the discovered resources estimated to occur within the undeveloped oil and gas fields scattered across the Arctic Alaska petroleum province. The sizes of these discoveries are poorly known, and some are listed with ranges of resources that reflect the uncertainty of the estimates. Most of these discoveries are located onshore on State of Alaska or Federal lands, but several sizeable and possibly commercial accumulations are located offshore. In the Beaufort Sea, a development plan for the Liberty field has been submitted by BPXA (anticipated first production in 2011; *Petroleum News Alaska*, 2007), and Shell has proposed a drilling program for Sivilluq field (formerly known as Hammerhead) The Kuvlum and Sandpiper discoveries are under active leases and presumably are being evaluated for additional drilling or seismic appraisal work. The Burger prospect attracted the most competitive bidding in Sale 193 (Feb. 6, 2008), garnering a total of $1,562,343,791 for 42 blocks and the highest aggregate bids for any single prospect. Also, the highest bid for any single block in Sale 193 was on the Burger prospect, $105,304,581 for block 6763 (OPD NR 03-02) or OCS Number Y-02279.

3.2.1.1.6. Exploration History. Petroleum exploration of the Northern Alaska province began with the establishment of the Naval Petroleum Reserve No. 4 (NPR-4) in 1923 on the basis of oil seeps near Cape Simpson. As a result of drilling from 1944-1953, small oil fields were discovered in NPR-4 at Umiat, Simpson, and Fish Creek. Gas fields were discovered at Gubik, South Barrow, Meade, Square Lake, Oumalik, and Wolf Creek. The South Barrow gas field supplied fuel to the Naval Arctic Research Lab in

Barrow for a number of years and continues to provide gas to the village of Barrow. In 1975, federally funded exploration resumed in NPR-4 and continued for 7 years. This drilling program found additional gas fields at East Barrow and Walakpa, both of which now produce gas for the village of Barrow. NPR-4 became NPR-A (National Petroleum Reserve in Alaska) in 1977, when the Department of the Interior received jurisdiction of the area from the U.S. Navy.

The State of Alaska held the first competitive lease sale on State lands (mostly in the 100-mi (161 km)-wide corridor between NPR-A and the Arctic National Wildlife Refuge (ANWR) (Figure 3.2.1-2) in northern Alaska in 1964. The State held a second competitive lease sale in 1965 that included the Prudhoe Bay structure. Atlantic Richfield Company and Humble Oil announced the discovery of the Prudhoe Bay field in 1968 after drilling the Prudhoe Bay State 1 well in 1967. Other oil fields discovered after the Prudhoe Bay discovery include Lisburne (1967), Kuparuk (1969), West Sak-Ugnu and Schrader Bluff (1969), Milne Point (1969), Gwydyr Bay (1969), Kavik (1960), Kemik (1972), Flaxman (1975), East Kurupa (1976), Point Thomson (1977), and Sag Delta-Duck Island (now Endicott; 1978).

Petroleum exploration of the Beaufort Sea Planning Area began with a joint State of Alaska/Federal offshore lease sale in December 1979 (Sale BF). Nine additional Beaufort Sea Federal lease sales were held from 1982 through 2007 (Sales 71, 87, 97, 124, 144, 170, 186, 195, and 202). All Beaufort Sea sales have together leased a total of 883 leases (approximately 5.0 millions of acres) for total high bonus bids of $3.633 billion (these statistics exclude 100 blocks leased for $28 million on Chukchi shelf). A total of 261 leases are (as of May 2008) active in the Beaufort Sea Planning Area. The locations of active Beaufort Sea leases are shown in Figure 3.2.1-3.

Industry investigations of the Beaufort Sea Planning Area have resulted in the collection of 99,000 line miles (159,291 line-kilometers [km]) of 2D (or traditional) seismic data and approximately 600 square mi (mi^2) or 1,554 square kilometers (km^2) of 3D (3-dimensional) seismic surveys (3D survey locations remain proprietary). The 2D "speculative" (shot by geophysical companies and then offered on the open market) seismic grid for the Beaufort and Chukchi Sea Planning Areas is shown in Figure 3.2.1-4.

A total of 36 wells have been drilled on the 983 Beaufort Sea leases taken since 1979. These wells led to a number of oil discoveries, with one field currently producing oil and four offering possible future commercial potential.

Northstar field, with ultimate reserves of 206 MMbbl, is producing approximately 40,000 bbl per day from sandstones correlative to the reservoir formation at the onshore Prudhoe Bay field.

The four undeveloped discoveries are listed in Table 3.2.1-3. At Tern Island (now Liberty), 105 MMbbl of oil was discovered in sandstones correlative to the reservoir formation at the Endicott field beneath State lands. The Hammerhead (now Sivulliq field) and Kuvlum wells discovered 100-200 MMbbl and 160-300 MMbbl of oil, respectively, in sandstones similar to (but older than) the reservoir formations at the onshore West Sak-Ugnu-Schrader Bluff "heavy" (high-viscosity) oil fields. (The onshore heavy oil fields are estimated to contain 21,000-36,000 MMbbl of oil in place at shallow depths within or below permafrost [*Oil and Gas Journal*, 2001:36].) At the Sandpiper field, wells encountered 47 MMbbl of light oil in sandstones correlative to the reservoir formation at the onshore Prudhoe Bay field.

Several other Beaufort Sea wells have encountered minor quantities of pooled oil and gas. These include the Phoenix 1, Antares 1 & 2, Mukluk 1, Mars 1, Galahad 1, and McCovey 1 wells (see Figure 3.2.1-2).

Four lease sales that offered different parts of the Chukchi shelf were held in 1988 and 1991. Prior to 1996, the Beaufort Sea Planning Area extended 100 mi (161 km) west of Point Barrow over a large area of the northeastern Chukchi shelf. The pre-1996 boundary is shown as a dotted line in Figure 3.2.1-5. In

1996, the Arctic offshore planning area boundaries were re-drawn into the modern configuration, as shown in Figures 3.2.1-1, 3.2.1-2, and 3.2.1-5.

The four sales (109 and 126 in the pre-1996 Chukchi; 97 and 124 in the Beaufort) that issued leases in the modern Chukchi Sea Planning Area prior to 1992 altogether collected $512 million in total high bids on 483 blocks (approximately 27 million acres). A map showing the location of leases issued prior to 1992 is shown in Figure 3.2.1-5. Industry, primarily Shell Oil, invested most of the high-bonus bids on just a few of the 42 prospects leased prior to 1992. Eighty-five percent of the $512 million bid in the 1988 and 1991 lease sales targeted the five prospects that were eventually drilled (Burger, Klondike, Crackerjack, Popcorn, Diamond; Figure 3.2.1-5). Of the 483 leases resulting from the 1988 and 1991 lease sales, all were relinquished by 1996.

Industry investigations of the Chukchi Sea Planning Area prior to the 1988 and 1991 lease sales resulted in the collection of 100,000 line-miles (160,900 line-kilometers) of 2D seismic-reflection data. The 2D "speculative" seismic grid in the Chukchi Sea Planning Area is shown in Figure 3.2.1-4. In addition, comprehensive gravimetric, magnetic, thermal, and geochemical surveys also were conducted in the Chukchi Sea Planning Area. In anticipation of Chukchi Sea Lease Sale 193, 3D seismic surveys were conducted during the 2006 and 2007 open-water seasons (late summer-fall) in the Chukchi Sea. These 3D surveys covered approximately 1,800 mi^2 or 4,662 km^2 (the survey locations are proprietary).

A total of five exploratory wells, at an estimated cost of $35 million apiece (Tarrant, 1991), were drilled on Chukchi shelf from 1989 to 1991 (Klondike OCS Y-1482-1 [1989]; Burger OCS Y-1413-1 [1989-1990]; Popcorn OCS Y-1275-1 [1989-1990]; Crackerjack OCS Y-1320-1 [1990-1991]; and Diamond OCS Y-0996-1 [1991]. Three wells were drilled over two open-water seasons. Four of the wells (Burger, Klondike, Crackerjack, and Popcorn) encountered pooled hydrocarbons. Burger prospect apparently hosts a large gas-condensate find and is estimated to contain discovered resources of 14.038 Tcf of gas and 724 MMbbl of condensate (most likely case; Craig and Sherwood, 2004).

Chukchi Sea lease sale 193 was held on February 6, 2008, and garnered $2,662,059,883 in total high bids for 488 blocks, or approximately 29 million acres. Twenty-seven prospects received bids in Sale 193. A map showing the locations of these bid blocks is shown in Figure 3.2.1-6. Sale 193 was dominated by Shell Gulf of Mexico, Inc., which submitted high (apparent winning) bids of $2,117,821,183 on 275 blocks. Most (91%) of the high bids (totaling approximately $2,433,309,630) targeted 164 blocks over the Burger, Crackerjack, and Klondike structures. In contrast to the earlier sales where they received approximately $41 million in high bids, the Popcorn and Diamond structures received only about $6 million in high bids in Sale 193.

3.2.2. Climate and Meteorology.

The climate of the coastal area bordering the Chukchi and Beaufort seas is classified tundra (Köppen climate classification scheme, mean temperature of the coldest month is <10 degrees Celsius (°C) (50 °Fahrenheit [°F]) but more than 0 °C (32 °F). Winters are bitterly cold, summers are cool, and annual precipitation is low.

During the winter season, the Beaufort-Chukchi Sea region is dominated by a ridge of high pressure linking the Siberian High and high pressure over the Yukon in Canada. Eastward moving western Pacific storm centers remain largely south of lat. 60° N.

Summer atmospheric-pressure patterns are more numerous and varied than in winter (Barry, 1979). Western Pacific low-pressure systems are more common north of lat. 60° N. These systems move northeasterly through the Bering Sea into the Chukchi Sea, where they follow the northwestern Alaska coast. Low-pressure systems generally bring cloudy skies, frequent precipitation, and southwesterly winds.

Weather patterns in the region are strongly influenced by variability brought about by the Arctic and North Atlantic Oscillations (AO/NAO) (Thompson and Wallace, 1998) and the Pacific Decadal Oscillation (PDO) (Mantua et al., 1997). These phenomena are similar to the El Niño-Southern Oscillation that dominates the equatorial Pacific Ocean. The AO alternates between positive and negative phases, influencing the weather patterns throughout the Arctic and Northern Hemisphere. Starting in 1989, the AO has tended to stay in the positive phase, causing lower than normal arctic air pressure, stronger westerly winds, and higher-than-normal temperatures. The PDO has been in a largely positive phase since 1976, when there was a fundamental shift towards warmer temperatures in Alaska. When the PDO index is positive, westerly winds in the Northern Pacific are stronger, thereby causing increased southerly flow and warm air advection into Alaska during winter, resulting in positive temperature anomalies. Major PDO eras have persisted for 20-30 years (Mantua et al., 1997).

3.2.2.1. Air Temperature. Subfreezing temperatures prevail for most of the year. Along the Chukchi Sea, the average mean temperature in February ranges from -9.3 °F (-22.9 °C) at Cape Lisburne to -22.9 °F (-30.5 °C) at Point Lay (www.wrcc.dri.edu). An extreme low temperature of -56 °F (-48.9 °C) has been recorded at Wainwright. Along the Beaufort Sea, the average mean temperature in February ranges from -18.0 °F (-28.8 °C) at Prudhoe Bay to -18.5 °F (-28.1 °C) at Kuparuk. An extreme low temperature of -62 °F (-52.2 °C) has been recorded at Prudhoe Bay. During winter, there may be prolonged periods of high winds, leading to extreme ice pressures and dangerous wind-chill conditions.

There is a brief summer season from June through August, with temperatures generally above freezing and precipitation falling in the form of rain. Along the Chukchi Sea, the average mean temperature in July ranges from 40.0 °F (4.4 °C) at Point Barrow to 45.2 °F (7.3 °C) at Cape Lisburne (www.wrcc.dri.edu). An extreme maximum temperature of 80 ˚F (26.7 ˚C) has been recorded at Wainwright. Along the Beaufort Sea, the average mean temperature in July ranges from 39.8 °F (4.3 °C) at Barter Island to 47.6 °F (8.6 °C) at Prudhoe Bay (www.wrcc.dri.edu). An extreme maximum temperature of 83 °F (28.3 °C) has been recorded at Prudhoe Bay and Kuparuk.

3.2.2.2. Precipitation. Along the Chukchi Sea, the average annual precipitation ranges from 4.21 inches at Point Barrow to 11.34 inches (in) at Cape Lisburne (www.wrcc.dri.edu). There is a great seasonal variation in precipitation with the months of February and March generally the driest and August the wettest. The average precipitation in the driest month ranges from 0.03-0.26 in. The average precipitation in August, the wettest month, ranges from 1.01 in at Point Barrow to 2.74 in at Cape Lisburne.

Along the Beaufort Sea, the average annual precipitation ranges from 4.02 in at Kuparuk to 4.8 in at Barter Island (www.wrcc.dri.edu). The average precipitation in the driest month ranges from 0.08-0.13 in. The average monthly precipitation in August ranges from 0.96-1.14 in.

Fog, rain, and snowstorms are dangerous weather phenomena that influence horizontal visibility. Very low visibility (<1 km) (0.6 mi) occurs most frequently in summer due to fog and in winter as a result of snowstorms. From June through August, the occurrence of low visibility in the open sea ranges from 25-30% (Proshutinsky, Proshutinsky, and Weingartner, 1998). This value decreases toward the mainland coast (10%).

3.2.2.3. Winds. During winter, northerly winds prevail in the Chukchi Sea, with directions ranging from northwest in the western part of the sea to northeast in the eastern part (Proshutinsky, Proshutinsky, and

Weingartner, 1998). During summer, the Chukchi Sea exhibits a more complicated wind regime, with alternating northerly and southerly winds.

Surface winds along the coast between Point Lay and Barrow commonly blow from the east and northeast. At Cape Lisburne, winds from the east and southeast prevail (Brower et al., 1988). The coastal wind speeds range generally from 4-8 meters per second (m/sec). Sustained winds of 26-29 m/sec, with higher gusts, have been recorded (Wilson et al., 1982).

The MMS has collected data from five meteorological stations from January 2001 through September 2006 at sites along a 100-km (62-mi) stretch of the Beaufort Sea coast centered on Prudhoe Bay. The sites were Milne Point, Cottle Island, Northstar Island, Endicott, and Badami. Wind directions at these stations have a strong bimodal distribution, with the greatest frequency from the east-northeast and a secondary maximum from the southwest to west-southwest. The average wind speeds range from 5.1-5.9 m/sec (11.4-13.2 miles/hour [mph]). Peak winds ranged from 22.9-27.9 m/sec (51-62 mph) (Veltkamp and Wilcox, 2007).

The data support the meteorological effects theorized by Kozo and Robe (1986) of a summer sea-breeze effect and orographic effects of the Brooks Range. The observations indicate that the sea-breeze effect is strongest in the months of May through July, although it is evidenced through September (Veltkamp and Wilcox, 2007). During early summer, onshore winds dominate local weather patterns in terms of both wind-direction frequency and duration. The sea-breeze effect is most pronounced at sites closest to the coastline, with the ratio of onshore to offshore winds in summer indicating a strong correlation to distance offshore. Summer wind speeds appeared to be highest centered on the coast, with wind speeds dropping with both distance offshore and inland. However, offshore data are limited to islands within several miles of the mainland.

3.2.2.4. Storms. Storms (wind velocities >15 m/sec) are observed more often in winter than in summer. In the Chukchi Sea, 6-10 storm days occur per month. The duration of storms ranges from 6-24 hours in 70-90% of cases, but stormy weather can last from 8-14 days (Proshutinsky, Proshutinsky, and Weingartner, 1998).

On October 3, 1963, an intense storm that hit Barrow with little warning and caused more damage than any other storm in its historical records is described in detail by Brunner et al. (2004). Wind gusts as high as 75-80 mph (33-36 m/sec) may have been reached, and the highest official observation of sustained winds was 55 mph (25 m/sec). The resulting storm surge (or rise in sea level) reached 10 ft, and may have been as high as 12 ft. The storm surge and wave action caused extensive flooding in coastal areas, and more than 200,000 cubic yards (yd^3) of sediment transport caused bluffs in the Barrow area to retreat as much as 10 ft (Brunner et al., 2004).

Since that episode, at least 30 storms have produced severe winds at Barrow and along the Chukchi coast (Brunner et al., 2004). The more notable of these are:

- September 12 and 20, 1986: The first of these storms from the southwest had peak and sustained winds of 56 and 38 mph, respectively; but the second storm was even stronger, with peak and sustained winds of 65 and 49 mph. Estimated damage to roads and structures in Barrow and Wainwright was more than $7.5 million.
- February 25, 1989: This storm hit from the southwest when the ice was in, with peak and sustained winds of 73 and 55 mph, respectively, and reported gusts close to 100 mph. An estimate of total damage to the North Slope Borough (NSB), including both private and public property, was more than $500,000.

- August 10, 2000: This storm hit from the west when the ice was out, with peak and sustained winds of 75 and 55 mph, respectively, equivalent to the October 1963 storm, but not as long lasting. The initial total damage estimate was about $7.7 million.

Lynch et al. (2001) document the Barrow high wind events from 1960-2000 and concluded that high-wind events are common in fall and winter and rare in April, May, and June. They have not yet concluded whether the more-frequent storms are part of a new pattern.

Sudden onsets of strong winds cause very hazardous conditions for Native subsistence hunters. In the Sale 124 Public Hearing in Kaktovik, Mr. Ningeok stated:

> …without any notice at all this storm would come upon us. No matter how beautiful a day, these sudden storms can come upon you. We were unloading the plane, at that moment, the plane did not leave, nor did we get done unloading the plane, and all the supplies for the DEW line were frozen out there because of this sudden snow storm which no one was able to do anything at all. (USDOI, MMS, 1990c).

Sarah Kunaknana reported that storms can come from different directions, but usually are from the north, and observed that the area inside the barrier islands is not affected heavily by storms (Sarah Kunaknan as cited in U.S. Army Corps of Engineers, 1999). Sarah Kunaknana indicated that a warm breeze and warming temperatures in summer are indicators of an impending major storm (USDOI, MMS, 1996d:2). In recent public meetings, Barrow whaling captains John Nusunginya and James Ahsoak described how the weather changes constantly and is very unpredictable, and that the biggest storms occur in September (USDOI, MMS, 1996d: 3). Jonas Ningeok, a Kaktovik resident, described the sudden and extreme storms that occur in the Alaskan Beaufort Sea:

> ...from experience, I know no matter how beautiful the day may look, in a moment's time, we can have a snow storm...that you can't even see [the] distance...to the end of the table.... It doesn't happen every year, but when it does happen, there's no telling [when].... As we were growing up, there have been several times when my...father [would] look up at the clouds, the sky, and tell us to get everything...all the firewood.... We'd get everything ready, and without any notice at all, it would seem like that all this storm would come upon us... (USDOI, MMS, 1990c:20-21).

Regarding conditions around the barrier islands bordering Stefansson Sound to the east of Prudhoe Bay, Vincent Nageak stated: "It is difficult to find a leeward side among any of those three groups of islands…so we usually go to Foggy Island for protection" (V. Nageak, as cited in Shapiro and Metzner, 1979).

Regarding Cross Island, Archie Ahkiviana stated:

> And then this high wind, we were down at Cross Island about a couple of years ago. We couldn't go off the island even though we'd gotten all our quotas in, 'cause of the high wind…. Well, there's just too much high winds. You know we go inside the Cross - those barrier islands. (Ahkiviana, as cited in USDOI, MMS, 2001).

Archie Ahkiviana stated at the public hearing of the Liberty draft EIS:

> We have been observing very high strong winds nowadays at Cross Island. A very strong East wind blew over the Winch Shack which was 16' x 24' and was completely destroyed; and a second building 9' x 40' trailer was destroyed and was found blown over to the lagoon at Cross Island. These strong winds have recently been observed. The Nuiqsut whalers regard these very strong winds unusual and blame this on global warming and climatic changes. These incidents happened in the fall of 1999 (Ahkiviana, as cited in USDOI, MMS, 2001).

3.2.2.5. Climate Change in the Arctic.

3.2.2.5.1. Climate Trends in the 20th Century. The arctic climate is undergoing changes as a result of global climate change as well as natural cyclical variations that include the PDO and AO/NAO discussed at the beginning of Section 3.2.2. It is not known to what extent global climate change may affect AO/NAO variability patterns. Observations of the AO/NOA patterns in the second half of the 20th century have not reflected changes predicted by models that incorporate changes in greenhouse gas concentrations (Fyfe, 2003).

Establishing climatic trends in the Arctic is challenging because of the small number of monitoring stations and the relatively short record of data. Data are available from fixed meteorological stations on land, drifting stations, and drifting buoys. The Russian North Pole drifting stations were first deployed in 1937, discontinued in 1991, and then resumed in 2003. Drifting buoys have been operating under the International Arctic Buoy Programme since 1979. The Arctic Climate Impact Assessment (ACIA, 2005) summarized spatial and temporal temperature trends in the Arctic based on observations from the Global Historical Climatology Network database (Peterson and Vose, 1997) and the Climate Research Unit database (Jones and Moberg, 2003). Both time series for stations located north of lat. 60° N. show a statistically significant warming trend of 0.09 °C (0.16 °F) per decade for the period of 1900-2003 (ACIA, 2005). The arctic trend is greater than the overall trend of 0.09 °C (0.16 °F) per decade for the Northern Hemisphere (Intergovernmental Panel on Climate Change [IPCC], 2001).

In general, temperatures increased from 1900 to the mid-1940s, decreased until about the mid-1960s, and then increased again up to the present. From 1966-2003, the average rate of temperature change for the Arctic was 0.40 °C (0.7 °F) per decade (ACIA, 2005). When temperature trends are broken down by season, the largest changes occurred in winter and spring. Temperatures in the marine Arctic measured by coastal land stations, drifting ice stations, and the Russian North Pole stations increased at the rate of 0.05 ˚C (0.1 ˚F) per decade in the 20th century (Polyakov et al., 2003).

An analysis by Rigor, Colony, and Martin (2000) for the entire Arctic Ocean for the period 1979-1997, indicates an increase in surface air temperature of about 1.0 °C (1.8 ˚F) per decade in the eastern Arctic, primarily north of the Laptev and East Siberian seas, whereas the western Arctic shows no trend or even a slight cooling in the Canadian Beaufort Sea. During fall, the trends show a cooling of about 1.0 °C per decade over the Beaufort Sea and Alaska (Rigor, Colony, and Martin, 2000). During spring, a significant warming trend of 2 °C (3.6 °F) per decade can be seen over most of the Arctic. Summer shows no significant trend.

Surface temperatures from satellite observations for the period 1981-2001 showed statistically significant warming in all areas to the north of lat. 60° N., except for Greenland (ACIA, 2005; Comiso, 2003). The warming trends were 0.33 °C (0.6 °F) per decade over the sea ice, 0.50 °C (0.9 °F) per decade over Eurasia, and 1.06 °C (1.9 °F) per decade over North America (ACIA, 2005).

A trend analysis for first-order observing stations in Alaska for the period of 1949-2007 shows an average temperature change of 3.4 °F (1.9 °C), with the figure for individual stations ranging from 1.3 °F (0.7 °C) at Kodiak to 4.2 °F (2.3 °C) at Barrow and Bettles (Alaska Climate Research Center, 2008). The largest increase was seen in winter and spring, with the smallest change in autumn. The trend has been far from linear. There was a decrease in temperature in the period from 1949-1976 followed by an abrupt increase in temperature in the period from 1973-1979 (Figure 3.2.2-1). The temperature shift in the 1970s corresponded to a change to a positive index of the PDO. Since 1979, only a little additional warming has occurred in Alaska with the exception of Barrow and a few other locations.

Figure 3.2.2-1 shows the temperature trend from 1949-2007 based on a best linear fit. The data show an increase in the mean annual temperature of 4.2 °F and 3.3 °F at Barrow and Kotzebue, respectively. Most of the temperature change occurred in winter and spring, with less of a change in summer and autumn. The fluctuation in annual average temperature from 1901-2007 for Barrow and Kotzebue are shown in Figures 3.3.2-2 and 3.2.2-3, respectively.

The greater amount of warming in the Arctic compared to that for the globe as a whole is consistent with climate model projections (IPCC, 2007). However, at present there is no definitive evidence of an anthropogenic signal in the Arctic, as no direct attribution study has been done (ACIA, 2005). Regional scale studies by Karoly et al. (2003); Zwiers and Zhang (2003); and Stott, Jones, and Mitchell (2003) tend to support the conclusion that temperature variations in North America and Eurasia probably are not due to natural variability alone. In the Arctic, natural variability is larger than in other parts of the world, so the anthropogenic signal is more difficult to detect. Scarcity of data in the Arctic also is a significant obstacle (ACIA, 2005).

The arctic environment poses unique problems to measurement of precipitation. Nevertheless, it appears that precipitation in the Arctic exhibits an upward trend, consistent with what is observed in mid-latitudes. Mean annual precipitation in the Arctic has increased at the rate of 1.4% per decade in the period of 1900-2003 and at a rate of 2.2% per decade in the period of 1966-2003 (ACIA, 2005). A few studies also indicate that an increasingly larger portion of precipitation falls in the form of rain (ACIA, 2005). Precipitation in Alaska also follows an upward trend. The fluctuation in annual average precipitation from 1901-2007 for Barrow and Kotzebue are shown in Figures 3.2.2-4 and 3.2.2-5, respectively. Annual snowfall in Alaska has increased by about 11%, but annual snow cover has decreased due to more rapid melting in spring and summer (Alaska Regional Assessment Group, 1999).

Satellite data have shown that arctic sea-ice extent has decreased by about 2.7% per decade during the period 1978 through 2005 (IPCC, 2007). This decreasing trend is observed in all seasons, but the greatest decrease is found in September with a trend of -8.6% per decade (Serreze, Holland, and Stroeve, 2007). 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 (National Show and Ice Data Center [NSIDC], 2007). The causes of the decline in sea ice are thought to be attributed to many variables, including a rise in air temperatures, changes in radiative fluxes from increases in greenhouse gases, and changes in wind circulation and ocean currents (Serreze, Holland, and Stroeve, 2007). A strongly positive value of the NOA index from the 1970s into the 1990s brought increased cyclonic activity in the Arctic, transporting warmer air into the region, and shifting sea ice farther away from the Siberian and Alaska coasts, and flushing more of the sea ice into the North Atlantic though the Fram Strait (Serreze, Holland, and Stroeve, 2007).

Subsea sonar measurements from submarines of ice draft (the submerged portion of sea ice) provide the primary source of information on ice thickness. Ice-draft measurements in the mid-1990s showed an average decline of about 42% compared to values in the period 1958-1977 (IPCC, 2007; Rothrock, Yu, and Maykut, 1999). There are indications that the decrease in sea-ice thickness was not gradual but occurred abruptly before 1991. However, not all studies show the same trend, and the limited coverage of observations makes it difficult to come to a general conclusion. The potential effects of climate change on sea ice are discussed further in Section 3.2.4.

Retreat of sea ice may have caused an increase in impacts to coastal areas from storms. Aerial photo comparison has revealed total erosive losses up to 457 m (1,500 ft) over the past few decades along some stretches of the Alaskan coast (Alaska Regional Assessment Group, 1999). Several villages have been sufficiently threatened by increased erosion and inundation that they must be protected or relocated (Alaska Regional Assessment Group, 1999). At Barrow, coastal erosion has been measured at the rate of

1-2.5 m/year since 1948 (ACIA, 2005), and it has been causing severe impacts on the community. For more information about changes in arctic sea ice, the reader is referred to Section 3.2.4.3.

Along a transect following the TAPS route, permafrost temperatures at 15- to 20-m depths have increased between 0.6 and 1.5 °C (1.1 and 2.7 °F) over the past 20 years. Borehole measurements have shown an increase of the mean annual ground surface temperatures of 2.5 °C (4.5 °F) since the 1960s, while discontinuous permafrost has begun thawing downward at a rate of 0.1 m/year at some locations (ACIA, 2005).

Information based on traditional knowledge also points to changes in the climate of the Arctic. Since the late 1970s, Alaskan Natives in communities along the coast of the northern Bering and Chukchi seas have noticed substantial changes in the ocean and the animals that live there.

> Beginning in the late 1970s, the patterns of wind, temperature, ice, and currents in the northern Bering and Chukchi seas have changed. The winds are stronger, commonly 15-25 mph, and there are fewer calm days. The wind may shift in direction but remains strong for long periods. In spring, the winds change the distribution of the sea ice and combine with warm temperatures to speed up the melting of ice and snow. From mid-July to September, there has been more wind from the south, making for a wetter season. With less sea ice and more open water, fall storms have become more destructive to the coastline (Pungowiyi, 2005).

A more detailed discussion of projected changes in the arctic climate and their potential effects on the planning areas for the proposed lease sales is given in Section IV.A.2.a of the Final EIS for the 2007-2012 OCS Oil and Gas Leasing Program (USDOI, MMS, 2007c).

3.2.2.5.2. Arctic Climate Variability Prior to the 20th Century. In the period of 120-90 million years before present (My BP), the Arctic was significantly warmer than at present (ACIA, 2005). Following this period, temperatures trended downward, ice accumulation started, and intensive glaciation commenced about 3.5-3 My BP. In the Quaternary Period (1.6 My BP-present), the global climate was characterized by alternating interglacial and glacial cycles. Each cycle can be subdivided further into stadials (shorter cold periods) and interstadials (shorter mild episodes). It has been estimated that during the Quaternary Period there have been between 30 and 50 glacial/interglacial cycles (ACIA, 2005). Various hypotheses have been considered to explain these variations, and include periodic orbital configurations described by Milankovitch (in Berger, 1988) and changes in the North Atlantic Ocean circulations.

The most recent interglacial episode took place in the period from 130-107 thousand years (Ky) BP. According to paleoclimate indicators, the climate during this time was somewhat warmer than at present. The last ice age started rather abruptly around 107 Ky BP. The glaciation reached its peak around 24-21 Ky BP, also known as the Last Glacial Maximum. Cold did not prevail continuously during this period. There were rapid warm and cold oscillations, called Dansgaard-Oeschger events. About 24 of these episodes have been found between 115 and 14 Ky BP (ACIA, 2005). A complete change to a much warmer climate would occur over a span over only a few decades. These interstadials typically would last from a few centuries to about 2,000 years. Return to colder conditions could be equally rapid.

The last ice age started to come to an end around 20 Ky BP and, by 10 Ky BP, temperatures were close to those of today. During this transition, there were periods of very rapid warming as well as sudden reversals to colder temperatures. Some of the warming rates, such as those found at the end of the Younger Dryas (around 11 Ky BP), were as high as 10 °C (18 °F) per 50 years. It appears that the climate around 8-5 Ky BP was significantly warmer than today. The latter half of the Holocene Period

(10 Ky BP-present) was somewhat cooler. In Alaska, pollen data seemed to indicate a drastic cooling around 3.5 Ky BP accompanied by an increase in glacial activity.

In the last millennium, what is called the "Medieval Warm Period" from the 9th to 15th century, was not a global phenomenon, but was limited primarily to the North Atlantic area (ACIA, 2005). For the Northern Hemisphere, there was a general cooling trend from the year 1000 to about 1850 or 1900. The climate of the Arctic in the period 1550-1900 may have been the coldest in the entire Holocene Period. The 20th century warming trend started around 1900.

In summary, the Arctic has seen very large cyclical variations over the past 2 million years. The changes also have not been uniform over the area. Large changes also have taken place abruptly, spanning just a few decades. The driving factors are complex but involve changes in solar radiation, atmospheric circulations, ocean circulations, and the cryosphere. Many of these factors tend to amplify changes resulting from the initial causal factor. The complexity of the interaction between the atmosphere, oceans, and the cryosphere adds to the challenge of attempting to project climatic changes resulting from increased greenhouse gas concentrations.

3.2.2.5.3. Projected Changes to Climate in the Arctic. The following discussion is based on information presented in the ACIA, 2005 report. The projected changes in the report were based on simulations from five different atmosphere-ocean general circulation models (AOGCMs). The models were (1) CGCM2 (Canadian Centre for Climate Modelling and Analysis), (2) CSM_1.4 (National Center for Atmospheric Research, USA), (3) ECHAM4/OPYC3 (Max-Planck Institute for Meteorology, Germany), (4) GFDL-R30_C (Geophysical Fluid Dynamics Laboratory, USA), and (5) HadCM3 (Hadley Centre for Climate Prediction and Research, UK). The atmospheric models have a horizontal grid resolution of about 200-300 km and have between 10 and 20 vertical levels. Some of the ocean models have somewhat greater horizontal resolution and have between 10 and 45 vertical levels (ACIA, 2005).

Important atmospheric processes in AOGCMs include clouds and radiation; convection; precipitation; orography; and heat, moisture, and momentum fluxes in the atmospheric boundary layer. These processes take place over a scale much smaller than the model grid. These factors must be represented in terms of the larger scale variables in the model. The Arctic presents unique challenges to climate modeling. Computational problems arise from converging meridians in the Arctic (ACIA, 2005). The atmospheric boundary layer in the Arctic has unique characteristics and, thus, standard techniques for treating it in the model may not be appropriate. There frequently are strong temperature inversions, and these may not be adequately resolved in the model. The simulation of ice depth, ice extent, and ice flow present challenges, as these can have a very significant feedback on the climate variables.

The five models were applied using the IPPC B2 emissions scenario (ACIA, 2005). This scenario assumes a society that in general puts somewhat greater emphasis on environmental than economic considerations with modest economic and population growth. The models projected a global mean temperature increase by the late 21st century of 1.4-2.1 °C (2.5-3.8 °F) (compared to the 1981-2000 period). For the Arctic, the mean temperature increase by 2071-2090 relative to a 1980-2000 baseline for the area to the north of lat. 60˚ N. ranges from 2.8-4.6 °C (5.0-8.3 °F). For the period 2041-2060, the mean temperature increase ranges from 2.2-3.2 °C (4.0-5.8 °F), with four of the five models predicting a temperature increase of between 2.2 and 2.5 °C (4.0-4.5 °F). The range of temperatures predicted by the models is the result of model differences as well as noise due to what is called internal variability. While the largest temperature increases were found in the Arctic, the internal variability also was higher in the Arctic than in the lower latitudes (ACIA, 2005). A statistical analysis of the model results indicated that at least for the next few decades, the temperature increase in the Arctic from greenhouse gases may remain difficult to differentiate from natural variability (ACIA, 2005). Later in the 21st century, the effects from greenhouse gases become more statistically significant.

The largest temperatures increases were found over the Arctic Ocean, the Canadian Archipelago, and the Russian Arctic. The projected temperature increase over the central Arctic Ocean was >5 °C (ACIA, 2005). There was considerable seasonal variability, with the largest increases found in autumn and winter, and the lowest increases occurring in summer, when the temperature increase over the Arctic Ocean was <1 °C (1.8 °F).

For areas to the north of lat. 60° N., the five models project an increase in annual precipitation of between 7.5 and 18.1% (ACIA, 2005). As with temperature, the largest increase occurs in autumn and winter, and the smallest increase in summer. The models also project a slight decrease in surface air pressure in the Arctic and an increase in cloud cover. In general, the models projected an increase in evapotranspiration (E) for the Arctic Ocean and five major watersheds, but there is considerable scatter in the results and, in each region, at least one of the models projected a decrease in the value. The value of precipitation (P) minus E showed a net increase for all except one model, with the largest increase occurring over the Arctic Ocean (ACIA, 2005). However, there was considerable seasonal variation with smaller values of P minus E in summer. This could mean that increased winter and spring flow rates could be followed by decreased flow rates in summer.

Modeling was performed to project sea-ice extent in the 21st century for March and September. It should be noted that there was considerable bias in the sea-ice projection for the baseline, with many of the models projecting values that are much lower than the observed values. The future projected values, therefore, were adjusted in an attempt to account for these biases. The CSM_1.4 projected only a slight decrease in sea ice through the end of the 21st century for March and September. On the other hand, the CGCM2 model projected an ice-free Arctic in September by the middle of the 21st century. The other three models projected a sea-ice extent for September by the end of the 21st century that is only about one-third of the current value. Most of the Arctic Ocean is projected to remain ice-covered in March, but the sea-ice edge is projected to retreat significantly in the subpolar seas. Some of the consequences of sea-ice loss would be increased atmospheric humidity, cloudiness, and precipitation. Ocean temperature, salinity, and stratification will change in some areas.

The IPCC projects that global sea level will rise by 0.11-0.77 m (0.4-2.5 ft) between 1990 and 2100, with an average value of 0.48 m (1.6 ft) (ACIA, 2005). This large range is due to the use of seven different models and many more emissions scenarios. The largest portion is due to thermal expansion, and most of the remainder due to glacier melting. There are large uncertainties in the contribution from the Greenland and West Antarctic ice sheets. Larger sea-level values are predicted for the Arctic. The NASA-GISS atmosphere-ocean model projects that the arctic sea level will rise by 0.73 m (2.4 ft) between 2000 and 2100. Thermal expansion contributes 0.31 m (1.0 ft) to the rise, while freshwater input contributes 0.45 m (1.5 ft) (ACIA, 2005; Miller and Russell, 2000).

In summary, ACIA applied five different climate models to project future Arctic climate. The models project a mean temperature increase for the Arctic of 2.2-3.2 °C (4.0-5.8 °F) by the middle of the 21st century and 2.8-4.6 °C (5.0-8.3 °F) by the end of the 21st century. The largest increases occurred in autumn and winter. Precipitation is projected to increase by about 8-18%, and P minus E is projected to increase, which would lead to increased runoff except, perhaps, in the summer. Sea ice is projected to decrease considerably, with most pronounced loss in early autumn. Sea level in the Arctic is projected to increase an average of 0.73 m (2.4 ft). Of all the parameters, sea-level rise has the largest uncertainty. Climate change in the Arctic is projected to be larger than in other areas of the globe. However, arctic climate has a larger natural variability and is highly complex and, therefore, climate projections may have greater uncertainty. Use of more advanced modeling techniques in the future along with more extensive observations should improve the capability in future climate projections.

3.2.3. Physical Oceanography.

3.2.3.1. Beaufort and Chukchi Seas: Water Depth and Generalized Circulation. The physical oceanography descriptions in Beaufort Sea Planning Area Oil and Gas Lease Sales 97, 124, 144, 170; the Beaufort Sea Multiple Sale (Sales 186, 195, and 202); and Chukchi Sea Planning Area Oil and Gas Lease Sales 109, 126, and 193 Final EISs (USDOI, MMS, 1987a, 1990a, 1996a, 1998a, 2003a, 2007d) and Beaufort Sea Planning Area Oil and Gas Lease Sales 195 and 202 Environmental Assessments (EAs) (USDOI, MMS, 2004, 2006b) are incorporated by reference. Brief summaries of these descriptions, updated and augmented by new material, are provided below.

The Beaufort Sea Sales 209 and 217 areas lie within the U.S. portion of the Beaufort Sea adjacent to northern Alaska. The Beaufort Sea extends east from Point Barrow, Alaska to Banks Island, Canada and northward into the Canada Basin (Figure 3.2.3-1). The Chukchi Sales 212 and 221 areas lie within the U.S. portion of the Chukchi Sea adjacent to northern Alaska. The Chukchi Sea extends west from Point Barrow, Alaska to the Russian Chukotka shoreline, northwest to Wrangel Island and south to the Bering Strait (Figure 3.2.3-1).

The Beaufort and Chukchi are marginal seas to the Arctic Ocean. The physical oceanography is influenced by: (1) the flow of water through the Bering Strait, Siberian Coastal Current, and the currents in the Chukchi Plateau and Canada Basin; (2) the atmospheric-pressure systems; (3) surface-water runoff; (4) density differences between water masses; and (5) seasonal and perennial sea ice.

Figure 3.2.3-1 shows the continental shelf, slope, rise, and abyssal plain within the proposed Beaufort Sea sale area. Water depths within the sales' areas range from about 1.5 m (approximately 5 ft) to more than 3,500 m (11, 482 ft). Approximately 75% of the proposed Beaufort Sea sale area has water depths >60 m. The major topographic features are Barrow Canyon and barrier islands and shoals. Shoals rise 5-10 m (16-33 ft) above the surrounding seafloor and are found in water depths of 10-20 m (33-65 ft). The barrier islands are shaped by waves in the short Arctic open-water season. They are narrow (<250 m), have low elevations (<2 m) and, particular to the Arctic, they are short (Stutz, Trembainis, and Pilkey, 1999). The shelf varies in width between Barrow and Canada and generally is a narrow shelf averaging about 80 km. Barrow Canyon is just northeast of Barrow, with depths ranging from 50-170 m. Barrow Canyon plays a role in draining water from the Chukchi Sea, creating eddies and bringing upwelled water from the basin to the shelf. East of the Beaufort sale areas, the Mackenzie trough and the Kugamllit Valley act as conduits for cross-shelf exchange.

Figure 3.2.3-1 shows that approximately 87% of the proposed Sales 212 and 221 area covers the relatively shallow (<100 m) Chukchi continental shelf adjacent to the Arctic Ocean. A small area in the northeastern portion overlies the continental slope and abyssal plain. Water depths within the proposed Chukchi Sea sale area range from approximately 20-3,500 m (65.6-11,482 ft). Hanna Shoal lies within the proposed sale area and Herald Shoal is adjacent to it on the western side. These shoals rise above the surrounding seafloor to approximately 20 m below sea level. There are two major sea valleys in the Chukchi Sea–Herald Canyon and Barrow Canyon. The Barrow Sea Valley begins north of Wainwright and trends in a northeasterly direction parallel to the Alaskan coast. Herald Valley is to the north adjacent to Wrangel Island, outside the sale area. Hope Valley, a broad depression, stretches from Bering Strait to Herald Canyon. These topographic features exert a steering effect on the oceanographic circulation patterns in this area.

The generalized Beaufort and Chukchi circulation is shown in Figure 3.2.3-2. From the northwest, the Siberian coastal current flows south along the Chukotka Peninsula and is present in summer and fall, but weak in fall and winter. The Bering Strait is the gateway between the northern Pacific and the Arctic. Although the flow through the strait is small in volume (~ 0.8 Sverdrups [Sv] northward in the annual mean [Sverdrup is a unit of volume transport equal to 1,000,000 cubic meters per second {m^3/sec.}]), due to its high heat and freshwater content, low density, and high nutrients, it has a large influence on the Chukchi Sea and the Arctic Ocean.

Three watermasses move through the Bering Strait: Anadyr Water, Bering Shelf Water (BSW), and Alaska Coastal Water. These watermasses cross the Chukchi Shelf and exit in four general areas: Long Strait, Herald Canyon, the Central Channel, and Barrow Canyon (Woodgate, Aagaard, and Weingartner, 2005). The Alaska Coastal Current flows northeastward along the Chukchi Sea coast at approximately 5 centimeters per second (cm/sec.) and drains into the Barrow Canyon (Johnson, 1989a; Weingartner et al., 1998). Barrow Canyon mean currents range from 14-23 centimeters per second (cm/sec.), with maximum current speeds of approximately 100 cm/sec. (Weingartner et al., 1998). Flow reversals occur in Barrow Canyon with upwelling. These reversals are tied to the pressure gradient associated with the variable longshore current (Johnson, 1989a; Aagaard and Roach, 1990).

On the continental slope, the Atlantic Intermediate Water of the Arctic Ocean circulates at approximately 200-1,500 m depth in a counterclockwise motion. Above the Atlantic Intermediate Water, in the absence of winds, is an eastward flowing boundary current (Pickart, 2004; Pickart et al., 2005;Weingartner, 2006; Mathis et al., 2007; Nikolopoulos et al., In press). Closer yet to the surface in the Canada Basin is the Beaufort Gyre, which circulates in a clockwise motion at a mean rate of about 5-10 cm/sec., but daily mean values may be 10-times greater.

3.2.3.2. Beaufort Sea. For this discussion, the Beaufort Sea is divided into two main oceanographic regions: offshore with water depths >40 m and nearshore with water depths <40 m.

3.2.3.2.1. Offshore. The offshore is seaward of the 40-m water-depth line and includes the outer shelf, slope, and deep basin. This region is highly influenced by the wind, sea ice, and watermasses from other portions of the Arctic and Chukchi shelf.

3.2.3.2.1.1. Offshore Watermasses. Offshore of the Alaskan Beaufort Sea shelf, the slope and abyssal plain extend into the Canada Basin. The Beaufort offshore waters of the Canada Basin show the "typical" Arctic structure with a cold halocline that insulates the warmer, deeper waters of Atlantic origin from the colder, fresher surface waters called the polar mixed layer. This water structure is important, because it keeps the warm Atlantic water from melting the polar ice.

From the surface to approximately 2,500 m, there are three general water mass divisions: a polar mixed layer, a halocline complex, and the Atlantic layer (called Atlantic Intermediate Water [AIW]). In the Beaufort Sea, the polar mixed layer occurs from the surface to approximately 50 m. The polar mixed layer primarily is wind driven. Precipitation, river inflow, and waters produced during ice melting accumulate in the mixed layer, all of which freshen the mixed layer in the summer months. In the winter period, the mixed layer is a source for ice forming, which increases salinity. From approximately 50-200 m is the halocline, and beneath that is AIW. On the Beaufort slope, the AIW temperature maximum occurs at a depth of 450 m (Pickart et al., 2005).

The halocline in the Canada Basin differs from the rest of the Arctic, because it is thicker and is supplied by waters of both Pacific and Atlantic origin. The Pacific halocline waters lie above the AIW (Eastern Arctic waters [Shimada et al., 2005]). The Pacific halocline waters transit through the Chukchi Sea and have varying life histories, depending on their residence time in and where they exit the Chukchi Sea (Shimada et al., 2005). There are three general types of Pacific halocline waters: two summer and one winter. The type and amount of these halocline waters varies with location in the Canada Basin.

The summer Pacific halocline is derived from Alaska Coastal Water (ACW) and summer Bering Sea Water (sBSW). The ACW forms in the nearshore environments of the Bering and Chukchi seas from warm, low-salinity runoff primarily from the Yukon and Kuskokwim rivers and warmed BSW. The sBSW is a product of BSW and Gulf of Anadyr Water (Shimada et al., 2001; Steele et al., 2004). The ACW generally is found at 40-70 m, and sBSW is generally found at 70-130 m in the Canada Basin (Steele et al., 2004). The winter Pacific halocline is derived from winter Bering Sea Water (wBSW). In the southern Beaufort Gyre, sBSW generally is missing, and the ACW overlies wBSW.

Because the Atlantic origin halocline waters are below the Pacific origin waters, they are called the Lower Halocline Water (LHW). There are two types of LHW of Atlantic origin. The first is the warm and oxygen-poor waters that are in the southwestern Canada Basin (Woodgate et al., 2006). The second is the cold and oxygen-rich waters in the northwestern Canada Basin (McLaughlin et al., 2004). The cold oxygen-rich water is thought to enter the Beaufort Gyre north of the Chukchi Plateau (Itoh et al., 2007).

From 2,400-2,700 m, there is an approximately 300-m stairstep series of two to three water masses of decreasing temperature and salinity (Timmermans, Melling, and Rainville, 2007). At >2,700 m depth, the water mass in the Canada Basin is old (>450 years) and well mixed, with stable salinity and temperature from 2,700 m to the bottom (Timmermans, Garrett, and Carmack, 2003).

3.2.3.2.1.2. Offshore Currents, Upwelling, and Eddies. The major feature of the mean surface flow in the Canada Basin is the clockwise circulating Beaufort Gyre. This surface circulation is maintained by the wind-stress pattern as modified by the ice cover and, in the shallower areas near the coasts and around the Chukchi Province, it is strongly affected by the bottom topography. The southern portion of the Beaufort Gyre is found in the offshore region of the proposed Beaufort Sea sales area. The Beaufort Gyre expands and contracts, depending on the state of the Arctic Oscillation (AO) (Steele et al., 2004). Below the surface flow of the Beaufort Gyre, the mean flow of the Atlantic layer (centered at 500 m) is counterclockwise within the Canada Basin. Below the polar mixed layer, currents appear to be driven primarily by ocean circulation rather than the winds (Aagaard, Pease, and Salo, 1988).

Along the Alaskan Beaufort slope, the water is a mixture of sBSW, wBSW, fresh-, and ice-melt water (Weingartner, 2006). A current, previously discussed as the Beaufort Undercurrent (Aagaard, 1984; Aagaard et al., 1989), which flows along the Alaskan Beaufort Sea slope, is now considered more of a narrow intensified jet with a mean speed of 15 cm/sec. (Pickart, 2004; Pickart et al., 2005; Nikolopoulos et al., In press). It is found above the AIW centered at approximately 170 m and exhibits a seasonal structure (Pickart, 2004, Nikolopoulos et al., In press). Its transport volume is estimated as 0.64 Sv or larger. This swift jet seasonally includes sBSW, wBSW, and upwelled Atlantic water, depending on the time of the year. The sBSW is generally found from midsummer to early fall. The wBSW is present in late spring to late summer, with the jet centered at 100 m. The upwelled Atlantic water is found midfall to spring, with the jet centered near 150 m. Weingartner (2006) identifies this current in the western and central moorings of the Alaskan Beaufort Sea showing a mean eastward flow, paralleling the isobaths, and suggesting this current largely follows the bathymetry.

Upwelling on the outer shelf and slope is defined by a reversal of the boundary current from easterly to westerly with the appearance of warm, saline water (Tsimitri and Pickart, 2006). Tsimitri and Pickart (2006) report that upwelling events occurred from September-May, were correlated to easterly winds, and factors such as sea ice and storm tracks affect the upwelling. Yang and Comiso (2007) identify strong upwelling in the fall, leading to a seasonal variability of salinity in the Beaufort Sea surface layers. The prevailing northeast windfield promotes westerly flow and upwelling along the shelf. Similar to Barrow Canyon, where upwelling occurs, recent studies identified large upwelling events occurring in the Mackenzie Trough and Kugmallit Valley (Williams et al., 2006, 2008). These events are forced by wind in the summer and ice in the winter. These upwelling events bring nitrate to the shelf from deeper waters where the nutrient maximum occurs.

Eddies are found throughout the southern and western Canada Basin with diameters from 10-20 km and concentrated in the halocline, but ranging shallower and deeper (D'Asaro, 1988; Pickart et al., 2005; Spall et al., 2008; Timmermans, Melling, and Rainville, 2007). These eddies carry shelf water to the Basin and are a source of nutrients and zooplankton to the offshore waters (Llinas et al., In press). Previously, it was thought these eddies were formed by the topography at Barrow Canyon. More recently, Spall et al. (2008) argue that these eddies form along the shelf break due to instabilities in the boundary current. Timmermans et al. (2008) identified shallow anticylconic eddies in the halocline as far north as lat. 79° N. These shallow eddies may have a significant impact on mixing in the halocline, and Timmermans et al. postulate these eddies form by differences in watermass fronts.

3.2.3.2.1.3. Offshore Temperature and Salinity. Near Barrow, the ACW has temperatures of 5-10 °C and salinities that generally are <31.5 parts per thousand (ppt); the sBSW temperatures are near 0 °C and have salinities of 32.2-33 ppt. Along the Alaskan Beaufort Slope at about 120 m, the salinity is approximately 33.1 ppt east of long. 152° W. (Okkonen and Stockwell, 2001). Temperatures range between -1.7 °C and -1.3 °C and generally are higher by about 0.1 °C west of long. 152° W. than to the east (Okkonen and Stockwell, 2001). Pickart (2001, 2004) and Pickart et al. (2005) show this cold, subsurface watermass as relatively stable seaward of the upper slope. Along the Alaskan Beaufort Slope, temperature and salinity measurements show considerable variation with differences in the western, central, and eastern portions of the shelf (Weingartner, 2006).

3.2.3.2.2. Nearshore. The nearshore is landward of the 40-m water-depth line and includes a series of bays, lagoons, and a sound enclosed by barrier islands in the central Beaufort. This region is highly influenced by the wind during the open-water season. Other influences include landfast ice, river discharge, ice melt, bathymetry, and how the coast is aligned. This nearshore area is a repository for freshwater draining from rivers and streams, making it estuarine during parts of the seasonal cycle. During this seasonal cycle, nearshore waters are made up of freshwater, marine water, and a mixture of both.

3.2.3.2.2.1. Nearshore Seasonal Cycles. The seasonal cycle modifies temperature and salinity properties through freezing, melting, and river discharge and, thus, changes the watermasses in the nearshore through time. In the Arctic spring (late May to early June), the small and large rivers break up and flow at maximum discharge over and under the still-frozen landfast ice, creating a large freshwater input on a short seasonal basis (Rember and Trefry, 2004; Alkire and Trefry, 2006).

From early June to July, the landfast and sea ice melts. Open water first occurs next to the river deltas and is mostly river water and ice meltwater (Niedoroda and Colonell, 1991). This water is brackish, meaning a mixture of fresh- and saltwater. Cold marine water lies adjacent to or below this surface layer (Colonell and Niedoroda, 1988). Due to the large density difference between the water layers and the >50% ice cover, there is little mixing of the fresh- and marine-water layers by the wind (Colonell and Niedoroda, 1988; Envirosphere, 1988).

By midsummer (mid-July to mid-Aug.), the open-water area becomes large enough for the wind to mix and circulate the water. The nearshore brackish water mixes to form a coastal watermass with a range of intermediate temperatures and salinity whose distribution is determined primarily by the wind. By late summer, freshwater discharge generally is low, and air temperatures fall. The water becomes marine and fairly uniform throughout the nearshore and offshore regions. The open-water area becomes the largest for the season.

In October to November, landfast ice and offshore sea ice begin forming. By November, sea ice covers most of the area. Through the winter, water temperatures decrease and ice continues to form. Joseph Nukapigak stated: "…in the Arctic, nine months out of the year…we have sea ice" (Nukapigak, as cited in USDOI, MMS, 1995a).

3.2.3.2.2.2. Nearshore Currents and Circulation. There are three distinct circulation periods; open water, river breakup, and ice covered (Weingartner, Okkonen, and Danielson, 2005). Tidal currents are <3 cm/sec. (very small) and most likely have a negligible dynamical effect on the currents and circulation.

The open-water circulation depends mostly on the wind, and the wind's direction is more important than its speed (Short et al., 1990; Weingartner, Okkonen, and Danielson, 2005). Thomas Napageak stated: "…they both work together, the current and the wind" (Napageak, as cited in Dames and Moore, 1996b:7). The wind's direction and how often it changes direction control the direction of surface currents, how long watermasses remain, and the amount of mixing between different watermasses. Maximum open-water currents in Stefansson Sound from 1999-2001 ranged from 58-100 cm/sec., with the mean speeds ranging from 0.5-7.3 cm/sec. (Weingartner, Okkonen, and Danielson, 2005).

The nearshore surface water responds quickly, within 1-3 hours, to changes in the wind direction from sustained easterly (or westerly) to sustained westerly (or easterly) (Hanzlick, Short, and Hachmeister, 1990; Segar, 1989). The two dominant wind directions are northeast and southwest (Morehead et al., 1992). Under easterly winds, water moves to the west. Under westerly winds, common in the fall and winter, surface water moves to the east. The mean surface-current direction year-round is to the west and parallels the bathymetry in an alongshore direction (Weingartner, Okkonen, and Danielson, 2005).

There are small cross-shore flows either to or away from shore. In addition to the water's eastward or westward motion, water also moves toward the shore or away from the shore. Under easterly winds, some water moves from onshore to offshore. This circulation pattern causes the gradual removal of warm, brackish water from the nearshore and replaces it with colder, more salty (marine) water. Under westerly winds, some water moves from offshore to onshore. This circulation pattern causes the accumulation of warm, less saline water along the coast and the depression of cold, saline marine water.

Causeways, such as West Dock and Endicott, may act as barriers to watermass circulation and mixing, depending on their length. Fechhelm et al. (2001) report causeway breaches at West Dock mitigate differences in cross-causeway temperature and salinity observations during the open-water season, but breaches at the Endicott causeway had no observable effect.

In contrast to the open-water season, the landfast ice season has a different circulation regime. The landfast ice insulates the water from the effects of the winds. Currents show little or no correlation to winds under the landfast ice (Weingartner, Okkonen, and Danielson, 2005). The circulation pattern is influenced by storms and brine drainage (Weingartner and Okkonen, 2001). Between mid-October and the end of June, under-ice current speeds seldom exceeded 10 cm/sec. The currents are relatively weak, but there are events of several days' duration when current speeds averaged about 10 cm/sec. at locations within Stefansson Sound (Weingartner, Okkonen, and Danielson, 2005).

The third circulation pattern occurs during the spring breakup of rivers. The spring river runoff results in an offshore spreading of a watermass under and over the landfast ice (Weingartner, Okkonen, and Danielson, 2005). Under-ice cross-shore flows of approximately 10 cm/sec. are observed. The transport of spring floodwater over and under the landfast ice indicates that a river plume under ice followed the local circulation. The Sagavanirktok River undiluted plume was mapped approximately 6-8 km offshore and 8-10 km alongshore, with the entire plume reaching approximately 17 km offshore (Alkire and

Trefry, 2006). The Kuparuk River plume mixes with and flows above the Sagavanirktok River plume, resulting in an increased northward flow of both plumes. Approximately 50% of the flow at that time was estimated to be under the ice, and the other half was assumed to flow above the landfast ice. This agrees well with a theoretical calculation that under-ice plumes could reach 20 km offshore.

Lagoon circulation patterns and water exchanges with the nearshore environment vary, depending on the lagoon type: open, pulsing, or limited exchange. Measurements in fall 2006 show water exchange between the Elson Lagoon and nearshore are dominated by tidal currents, but that subtidal currents are forced by changes in wind speed and direction (Okkonen, Ashjian, and Campbell, 2007). When the wind blows from the west-southwest cooler, saltier water flows into the lagoon; and when winds blow from the east warmer, fresher water flows out of the lagoon. Satellite images show fronts associated with these freshwater flows in the nearshore.

3.2.3.2.2.3. Nearshore Temperature and Salinity. The nearshore area exhibits a wide range of temperatures and salinities based on a generalized open-water pattern. The main factors determining the water's characteristics are the wind, freshwater runoff, and sea ice. During early summer, the rivers overflood and the sea ice begins breaking up. The areas adjacent to the coast are warm and relatively fresh. These warm and freshwaters are underlain by marine waters, resulting in a stratified water column. Storm events serve to mix the water column, which results in an unstratified water column that is mixed from the surface to the bottom.

During winter, the water column generally is unstratified and fairly uniform. Temperature decreases rapidly from late September through mid-October (Weingartner and Okkonen, 2001). It remains at the freezing point about -1.7 °C until June. Salinities are approximately 28-32 ppt before the landfast ice develops. By January, salinities range from 24-35 ppt (Weingartner and Okkonen, 2001).

3.2.3.2.2.4. Tides and Storm Surges. The semidiurnal tidal range is 6-10 cm in the Beaufort Sea (Matthews, 1980; Kowalik and Matthews, 1982; Morehead et al., 1992). Tidal currents generally are weak, about 3-4 cm/sec. (Kowalik and Proshutinsky, 1994; Weingartner, Okkonen, and Danielson, 2005). Both positive and negative storm surges occur.

Roxy Ekowana stated: "Such a strong west wind and I found out that it was also high tide" (Ekowana, as cited in NSB, Commission on History and Culture, 1980:115). In a Northstar public meeting, Thomas Napageak relayed knowledge of the interaction between wind and water levels: "…you don't get…high tides [storm surges] on a northeast wind…. But when we've got the southwesterly wind, that's when the tide [water level] comes up." (Napageak, as cited in Dames and Moore, 1996b:7). Frank Long, Jr., described how a rising tide or storm surge can force water over the top of sea ice and flood river drainages: "If there's enough water that comes in, it'll bring the ice up, plus water will be flowing…up over the edge." (Long, as cited in Dames and Moore, 1996b:8). An example of a negative storm surge also was observed by Nuiqsut whaling captains who reported that in 1977, the water drained out of a bay near Oliktok Point and then came back in (Dames and Moore, 1996b:3).

3.2.3.2.2.5. Stream and River Discharge. Along the Alaskan Beaufort Sea, very few rivers on the Alaska North Slope are measured for discharge. Table 3.2.3-1 shows the known flow characteristics of North Slope streams and rivers that drain into the Beaufort Sea. Flow generally is nonexistent or at least immeasurable through most of the winter. Stream flow begins in late May or early June as a rapid flood event termed "breakup" that, combined with ice and snow damming, can inundate extremely large areas in a matter of days. More that half of the annual discharge for a stream can occur during a period of several days to a few weeks (Sloan, 1987; Rember and Trefry, 2004; Weingartner, Okkonen, and Danielson, 2005). Most streams continue to flow throughout the summer but at relatively low discharges. Runoff from rainstorms produces increased stream flow, but it seldom is sufficient to cause flooding.

Stream flow ceases at most streams shortly after freezeup in September. In the Beaufort, the Mackenzie River contributes the largest amount of freshwater, approximately 330 cubic kilometers (km^3) per year (Carmack et al., 2006), and it flows all year long.

3.2.3.3. Chukchi Sea.

3.2.3.3.1. Currents and Circulation. From the Bering Sea, water moves north through the Chukchi Sea into the Arctic Ocean (Coachman and Aagaard, 1988). The northward flow through the Bering Strait opposes the mean winds and is driven by a mean sea-level slope (approximately 0.5 m) to the north. Annual transport shows seasonal variation, with winter transport averaging a third of the summer transport (Coachman and Aagaard, 1988; Roach et al., 1995; Cherniawsy et al., 2005). Woodgate, Aagaard, and Weingartner (2005) report monthly mean velocities of approximately 10 cm/sec. and 30 cm/sec. for January and June, respectively, with an uncertainty on the order of 20% on these estimates. Annual mean transport is 0.8±0.2 Sv (Roach et al., 1995). The flow through the Bering Strait can reverse under strong northerly winds.

The Siberian Coastal Current (SCC) flows from north to south along the northern Chukotka Peninsula when it is present. The SCC is forced by winds, ice melt, and Siberian river outflow from the Kolyma and Indigirka rivers as well as numerous smaller ones. Both river run off and winds vary throughout the year as well as between years. In 1995, the SCC was not present, and flow was northward from the Chukchi to the Siberian Sea through Long Strait (Weingartner et al., 1999; Munchow, Weingartner, and Cooper, 1999). At Bering Strait, the SCC mixes with the incoming flow. Occasionally, when Bering Strait flow reverses, the SCC can be found south of Bering Strait. Offshore of the Chukotka Peninsula, there is a front that separates the cold, dilute Siberian Coastal Water from the warmer, saltier Bering Sea Water. The mean transport of the SCC is small, on the order of 0.1 Sv (Weingartner et al., 1999).

Flow in the Chukchi Sea generally is northward from the Bering Strait and, in general, is topographically steered. The mean northward transport can be interrupted by wind-forced currents, and the variations can be large (Weingartner et al., 1998; Woodgate, Aagaard, and Weingartner, 2005). Four generalized pathways of northward flow are recognized. Along the Alaskan Chukchi Coast is the ACW, a portion of which is within the Alaska Coastal Current (ACC), which exits through Barrow Canyon. A portion of the water entering Bering Strait moves northward along the Hope Valley and drains through Herald Canyon to the Arctic Ocean. The third path flows through the Central channel between Herald and Hannah shoals and may return to flow through Barrow Canyon or flow off the shelf into the Arctic basin. The last path flows through Long Strait. Woodgate, Aagaard and Weingartner (2005) estimate that about 0.18 Sv leaves through Long Strait from the Chukchi Sea.

The influence of Kotzebue Sound on the Chukchi Sea may be significant in reinforcing the ACC. The ACC flows northeastward along the Chukchi Sea coast at approximately 5 cm/sec. and drains into the Barrow Canyon (Johnson, 1989; Weingartner et al., 1998). The ACC flow is variable, and reversals in direction can persist for several weeks (Wilson et al., 1982; Aagaard, 1984; Weingartner et al., 1998); a large part of the flow variability is wind driven. Thus, during summer, the ACW may be absent from some parts of the Chukchi Sea coastal area because of prolonged (southerly) flow reversal or offshore diversion (Aagaard, 1984). Feder et al. (1989) determined that the coastal region of the northeast Chukchi Sea responds rapidly (within 6 hours) to wind forcing from Point Barrow to Point Hope. During northeasterly flow, anticyclonic (clockwise) eddies can separate the nearshore circulation from the ACC, between Cape Lisburne and Icy Cape (Wiseman and Rouse, 1980); off Icy Cape (Hufford, Thompson, and Farmer, 1977); and in Peard Bay (Hachmeister and Vinelli, 1985).

The ACC flows northeastward along the Chukchi Sea coast at approximately 5 cm/sec. and drains into the Barrow Canyon (Johnson, 1989; Weingartner et al., 1998). Strong, persistent, northward flow has been observed in Barrow Canyon (Woodgate and Aagaard, 2005). Both ACW and winter-transformed BSWare found in Barrow Canyon. At the head of the canyon they flow side by side. By the time they reach the mouth, ACW overlies winter-transformed BSW (Pickart et al., 2005). Barrow Canyon's mean currents range from 14-23 cm/sec, with maximum current speeds of approximately 100 cm/sec (Weingartner et al., 1998). Flow reversals occur in Barrow Canyon, with upwelling of Atlantic water onto the shelf. These reversals are tied to the pressure gradient associated with the variable longshore current (Johnson, 1989; Aagaard and Roach, 1990). The mean transport volume for Barrow Canyon is not well documented but is estimated at approximately 0.3 Sv (Pickart et al., 2005).

The other canyon that drains Chukchi shelf waters northward is Herald Canyon. The east and west sides of Herald Canyon show differences in watermasses and currents. Bering Sea waters, both summer and winter, flow along the eastern side of the canyon. A jet of summer water with current speeds in excess of 50 cm/sec. contrasts the winter water which moves more slowly with speeds of approximately 5-10 cm/sec. (Pickart et al., In press). Pickart et al. (In press) suggest that the coldest water entering the canyon switches sides, turns right, and reinforces the coastal jet found along the outer Chukchi and Beaufort shelves.

3.2.3.3.2. Watermasses. The freshwater that flows through the Bering Strait is important to the Chukchi Sea establishing its watermasses and to the larger Arctic Ocean freshwater budget (Woodgate and Aagaard, 2005; Shimada et al., 2001, 2005; De Boer and Nof, 2004). Three watermasses move through Bering Strait's eastern and western channels. Anadyr water moves through the western channel, in the Russian Exclusive Economic Zone. The Anadyr Current is nutrient-rich, deeper, Bering Sea water that is upwelled onto the shelf in the Gulf of Anadyr. It flows west to east in the region south of Bering Strait throughout the year and is the major forcing function for high production in the region.

The two other watermasses, the BSW and the ACW, enter the Chukchi Sea through the eastern Bering Strait channel. These two watermasses are distinguished by salinity differences (Aagaard, 1987). The BSW is more saline, forms in the northern-central Bering Sea, and flows northward through the western Bering Strait parallel to the bathymetry. In the Chukchi Sea, Anadyr water and BSW mix to form the Bering Sea Water. The ACW is characterized by lower salinity and warmer temperatures, and it follows the Alaskan coast northward and enters the Arctic Ocean and the Beaufort Sea west of Point Barrow.

The horizontal gradients between watermasses on the inner and outer shelf maintain a front of variable strength (Feder et al., 1990). This front represents a boundary between the BSW and the ACW. In the spring, summer, and fall, these watermasses are modified by the winds and freshwater input along the Alaskan coast. The general cycle of the watermasses is cooling in fall, increasing salinity in winter, and warming and freshening starting in spring and continuing into summer. Large changes in temperature and salinity occur throughout the year, with the largest variability along the Alaskan Chukchi coast. The flow differences of these watermasses produce a varying residence times for watermasses on the Chukchi shelf ranging from 1-6 months (Woodgate, Aaagard, and Weingartner, 2005).

Off the Chukchi Alaskan coast, a series of polynyas form between Point Hope and Barrow during winter (Stringer and Groves, 1991). Salt rejection from ice formation in these polynyas creates dense, cold, super-salty watermasses and causes a seaward flow of the denser water (Cavalieri and Martin, 1994; Winsor and Bjork, 2000). These dense waters may be advected to deeper water by eddies (Winsor and Chapman, 2002). There is disagreement between scientists regarding the polynya area and the amount of ice production leading to salinity forcing (Martin et al., 2004; Weingartner et al., 1998). In some years, freezing in polynyas is insufficient to produce a dense, cold, super-salty watermass. The Wrangel Island polynya also is a source of dense, cold, super-salty water for Herald canyon (Pickart et al., In press).

Tides are small in the Chukchi Sea, and the range generally is <0.3 m. Tidal currents are largest on the western side of the Chukchi and near Wrangel Island, ranging up to 5 cm/sec. (Woodgate, Aagaard, and Weingartner, 2005). Storm surges are both positive and negative. Winds from the west are associated with positive surges, and winds from the east are associated with negative surges. In late fall, the lack of sea ice increases the open-water area enhancing water transport and increasing wave height (Lynch and Brunner, 2007).

3.2.3.4. Beaufort Sea and Chukchi Sea Changes in Physical Oceanography. Various reported changes in the physical oceanography of the Beaufort and Chukchi seas include increases in temperature, heat, and freshwater content and changes in salinity. Changes in the Bering Sea as well as the Arctic Ocean have complex interactions with the Chukchi and Beaufort seas. We do not know to what extent the recent changes in the Arctic Ocean are cyclic, whether they represent a linear trend, or if they are a modal shift.

Substantial changes have occurred in the Arctic region over the last few decades. Shifts in atmospheric circulation patterns have resulted in increased transport of Atlantic waters entering the Arctic via Fram Strait (Rudels et al., 2000). The warming of the Atlantic Layer resulted from changes in inflow from Fram Strait and the Barents Sea as well as changes in local current speeds (Swift et al., 1998; Zhang, Rothrock, and Steele, 1998; Karcher et al., 2003; Polykov et al., 2007). This intrusion of warm water from the North Atlantic found its way to the Arctic Ocean along the continental margins of the Eurasian and Canada basins.

A series of anomalously large, lateral heat inflows into the Atlantic Water Layer of the Arctic Ocean have occurred since the late 1980s. As a consequence, temperatures of the Arctic basins at mid-depth increased considerably in comparison to earlier decades (Carmack et al., 1995; McLaughlin et al., 1996; Morrison, Steel, and Anderson, 1998; Grotefendt et al., 1998). The temperature anomalies appeared first on the Markov Basin side of the Lomonosov Ridge and then arrived on the Amundsen side of the basin approximately 7 years later (Kikuchi, Inoue, and Morison, 2005) and finally the Canada basin.

The warming of the Atlantic Layer resulted from changes in inflow from Fram Strait and the Barents Sea as well as changes in local current speeds (Swift et al., 1998; Zhang, Rothrock, and Steele, 1998; Karcher et al., 2003; Polykov et al., 2007). The pronounced warming of Atlantic water in the Central basin tapered off by 1998-1999 (Gunn and Muench, 2001; Boyd et al., 2002). Morrison et al. (2006) report a relaxation to the pre-1990s hydrography at the North Pole.

Determining whether these warming trends persist depends on acquiring additional data. In the eastern Eurasian Basin, two warm Atlantic Water anomalies (1999 and 2004) are propagating towards the Arctic Ocean interior with a time lag (Polyakov et al., 2005, 2007). The magnitude of the 2004 anomaly is unprecedented as well as its horizontal and vertical extent (Polyakov et al., 2007). Polyakov et al. (2004) present data showing multidecadal fluctuations in temperature, with time scales of 50-80 years for Atlantic Water temperature variability. Swift et al. (2005) also show that there have been previous periods of warmer Atlantic Water temperatures through time.

In the Chukchi Sea, Woodgate et al. (2001, 2007) and Zhao, Gao, and Jiao (2005) present observations of warming and cooling events near the Chukchi Borderlands. In the Beaufort Sea, the Canada Basin hydrography in the 1990s also changed. Shimada et al. (2005) and McLaughlin et al. (2005) identify the remnants of this warmed Atlantic Water recently reaching the Canada Basin. Comparisons of recent and historical data show that the Canada Basin waters are in transition and are responding to inflow from upstream basins (McLaughlin et al., 2004, 2005). The appearance of higher temperatures near the Chukchi Plateau suggests that temperatures may continue to increase adjacent to the Chukchi and Beaufort shelves in the coming years.

Steele et al. (2004) state that the distribution of summer Pacific halocline is changing in the Canada Basin, and so is its influence. They relate these changes to the two different AO states where, during a high AO, ACW and sBSW may outflow at different locations from the Arctic. During a low AO, both watermasses are mixed into the Beaufort Gyre, and the separation of these watermasses is reduced.

The increase in temperatures of the Pacific halocline water is associated with an increased heat flow through Bering Strait. The annual mean water temperatures have increased approximately 1 °C since 2002, and the annual mean transport also has increased through Bering Strait (Woodgate et al., 2006). Along the Chukchi coast near Barrow, surface ocean temperatures have increased by 2 °C from 1982-2002 (Lynch and Brunner, 2007). Chukchi and western Beaufort Sea summertime sea-surface temperatures rose to 5 °C above average in 2007 (Steele, Ermold, and Zhang, 2008). Other parts of the Bering Strait and Chukchi Sea saw sea-surface temperatures that were 3-5 °C (5.4-6.3 °F) warmer than historical averages (Steele, Ermold, and Zhang, 2008). They documented warming increases since 1995, and especially since 2000.

Carmack and Chapman (2003) discuss increasing upwelling of warm Atlantic water along the shelf break due to the reduction of sea ice and an increase in wind-driven circulation.

The Beaufort Gyre is the major reservoir of freshwater in the Arctic Ocean. In 2000-2006, the total freshwater content in the Beaufort Gyre has not changed dramatically relative to climatology, but there is a significant change in the freshwater distribution. The center of the freshwater maximum has shifted toward Canada and significantly intensified relative to climatology. Significant changes were observed in the heat content of the Beaufort Gyre. It has increased relative to the climatology, primarily because of an approximately twofold increase of the Atlantic layer water temperature (Shimada et al., 2004). The Pacific water heat content in the Beaufort Gyre regions also has increased, and it is possible that the pronounced sea-ice reduction in this region, observed in 2006, resulted from heat released from this layer (Shimada et al., 2006). It is speculated that the major part of these changes in the freshwater and heat content occurred in the 1990s, but there are not enough data to confirm this.

Unlike the remainder of the Arctic, as noted above, air and ocean temperatures in the Bering Sea cooled significantly in 2006 and early 2007 compared with the previous 6-year period of warm temperatures (USDOC, NOAA, 2007). Because of this dramatic shift in ocean and ice conditions, the future state of the Bering Sea is now less certain and, therefore, the state of its contribution to the Chukchi Sea.

The Beaufort and Chukchi seas are particularly sensitive to long-term changes and low-frequency modes of atmosphere-ocean-sea ice forcing arising from climate change. Observations in the next years may be particularly significant in view of the changes observed in the AO, which had a persistent, positive phase through the 1990s, but it has been negative or near neutral for 6 of the previous years from 1996-2004 (Overland and Wang, 2005). This warming in the early 1990s was thought to be associated with cyclical, large-scale shifts in atmospheric forcing called the Arctic Oscillation (Proshutinsky and Johnson, 1997; Proshutinsky et al., 2000). Even without the driving force of a positive AO, Arctic indicators continue to show a continuing linear trend of warming (Overland, Wang, and Salo, 2008). Tracking multiple lines of evidence will be crucial to understanding change in the Arctic as a whole (Overland, 2006).

3.2.4. Sea Ice.

This discussion begins with the general characteristics of sea ice that are common to both the Chukchi Sea and Beaufort Sea sales' areas and then focuses on characteristics particular to each area. The sea ice descriptions in Beaufort Sea Planning Area Oil and Gas Lease Sales 97, 124, 144, 170, 186, 195, and 202 and Chukchi Sea Planning Area Oil and Gas Lease Sales 109, 126, and 193 Final EISs (USDOI, MMS, 1987a; 1990a; 1996a; 1998a, 2003a) and Beaufort Sea Planning Area Oil and Gas Lease Sales 195 and

202 EAs (USDOI, MMS, 2004; 2006b) are incorporated by reference. Brief summaries of these descriptions, updated and augmented by new material, are provided below.

In the proposed sales areas, sea-ice extent has a large seasonal cycle, generally reaching a maximum extent in March and a minimum in September. There is a large amount of interannual variability in the formation and breakup patterns of sea ice. The arctic sea ice is changing, and these changes are discussed in Section 3.2.4.3

Sea ice forms by the freezing of the polar oceans. Sea ice is frozen ocean water with most of the salt extruded out. The rejection of salt- or freshwater during sea-ice growth or melt strongly affects the density of the upper ocean and the behavior of watermasses. The formation of sea ice has important influences on the transfer of energy and matter between the ocean and atmosphere. It insulates the ocean from the freezing air and blowing wind. It also plays a complex role in the interactions of climate. It is an important component of climate, because it is a strong insulator and shortwave reflector. In addition, drifting sea ice can transport sediments and contaminants throughout the Arctic.

There are three general forms of sea ice in the proposed sales areas: (1) landfast ice, which is attached to the shore, is relatively immobile, and extends to variable distances offshore; (2) stamukhi ice, which is grounded and ridged ice; and (3) pack ice, which includes first-year and multiyear ice, which moves under the influence of winds and currents. These general ice types vary spatially and temporally in the sale areas and are strongly influenced by the bathymetry and location of offshore shoals as well as the atmospheric-pressure fields.

Along the Alaskan Beaufort and Chukchi seas, landfast ice usually re-forms yearly, although it can contain floes of multiyear pack ice. The two types of landfast ice are bottomfast and floating. Bottomfast ice is frozen to the bottom from the shore out to a depth of about 2 m. In water depths >2 m, the landfast ice is floating. By late winter, first-year sea ice in the landfast-ice zone is about 2 m thick. The landfast-ice zone extends from the shore out to the zone of grounded ice ridges.

Map 6 in USDOI MMS (2003a) showed the general northerly progression of landfast ice by month throughout the Arctic winter. The landfast ice is characterized by a gradual advance from the coast in the early winter and a rapid retreat in the spring (Mahoney et al., 2007). The advance is not a continuous advance but involves the forming, breakup, and re-forming of the landfast ice.

The nearshore landfast ice generally is smooth. Etta Ekolook stated: “The ice inside the barrier islands is smooth and remains so until it thaws out in the spring time” (Ekolook, as cited in NSB, Commission on History and Culture, 1980). Tidal cracks form within the ice sheet. Bruce Nukapigak states: “When it’s high tide these cracks [tidal crack] usually widen and close or even jam up when the tide goes down…. There is this type of crack on both sides of McClure Islands out from the mainland to the ocean” (Nukapigak, as cited by Shapiro and Metzner, 1979).

Large landfast ice movement occurs in two general ways: (1) pileups and rideups and (2) breakouts. The onshore movement of sea ice in the landfast-ice zone is a relatively common event that generates pileups and rideups along the coast and on offshore barrier islands. The onshore pileups often extend up to 20 m inland from the shoreline over both gently sloping terrain and up onto steep coastal bluffs. Ice rideup, in which the whole ice sheet slides relatively unbroken over the ground surface for more than 50 m, does not happen often; rideups beyond 100 m are rare. The landfast ice may move several hundred meters during early winter due to these processes. Landfast ice also may move due to “breakouts,” where the landfast ice breaks off and drifts with the pack ice (Eicken et al., 2006).

The ice zone that lies seaward of the landfast ice has been referred to as the stamukhi (shear or flaw) zone. This zone is a region of dynamic interaction between the relatively stable ice of the landfast-ice zone and the mobile ice of the pack-ice zone that results in the formation of ridges, leads, and polynyas (large areas of open water surrounded by ice). Large pressure ridges and rubble fields occur between the moving pack ice and the stationary fast ice. When winds drive pack ice into fast ice, or grind it up against the fast ice laterally along the edge, pressure ridges are formed. Between the landfast-ice zone and the stamukhi zone is a lead system.

The pack-ice zone lies seaward of the stamukhi zone and includes first-year ice, multiyear undeformed and deformed ice, and ice islands. Long-term movement of the pack ice is controlled by atmospheric systems and oceanographic circulation. The pack ice adjacent to the Beaufort and Chukchi has a mean clockwise motion in the Canada Basin. Changes in surface winds associated with the fluctuations and trends of Arctic Oscillation (AO) are correlated to sea-ice motion in the Beaufort and Chukchi (Proshutinsky and Johnson, 1977; Rigor, Wallace, and Colony, 2002). During a high AO, the Beaufort Gyre is smaller and weaker, and ice is advected directly over the pole and out Fram Strait. There is less ridging and the ice is thinner, and the transit times are longer from the Chukchi Sea. During a low AO, the Beaufort Gyre is bigger and stronger and ice is advected east, with more ridging and with longer advection times out of the Arctic basin (Rigor, Wallace and Colony, 2002). Zhang and Liu (2007) confirmed that the strength and size of the Beaufort Gyre changes from one winter to the next. Of the 15 winter seasons studied from 1988-2003, there were strong or normal Beaufort gyres alternating with weak or no Beaufort gyres every 1-3 winter seasons. Summertime anomalies also exist where sea ice is directed form the Chukchi Sea toward Fram Strait, causing low sea-ice extent in September along the Siberian and northern Alaska coasts (Ogi and Wallace, 2007).

The general pack-ice drift generally is to the west at an average rate of 3 cm/sec. Pack ice is made up of first-year and multiyear ice. The first-year ice that forms in the fractures, leads, and polynyas (large areas of open water) within the pack-ice zone varies in thickness from a few centimeters to more than a meter. Multiyear ice is defined as ice that has survived one or more melt seasons; undeformed multiyear ice is believed to reach a steady-state thickness of 3-5 m. Undeformed ice floes with diameters >500 m occupy about 60% of the pack-ice zone; some floes may have diameters up to 10 km.

Ice islands are large, tabular icebergs that calve (break away) from the ice shelves located along the northern coasts of Ellesmere and Axel Heiberg islands and drift into the Arctic Ocean, where they slowly circulate in a clockwise direction. In August 2005, the Ayles Ice Shelf broke off in the Canadian Arctic. The calving event was the largest in the last 25 years and raised concerns for oil and gas infrastructure. Ayles Ice Island drifted southwesterly for 2 years and, in August 2007, became wedged into the Sverdrup Inlet of the Queen Elizabeth Islands, and broke into two parts earlier than expected due to the reduced ice cover in 2007 (Shukman, 2007a,b).

Polynyas (large areas of open water surrounded by ice) are present on the Arctic shelves either through most of the year or during part of it. Winter polynyas are significant producers of sea ice, leading to the formation of brine that increases the density of the underlying waters. Polynyas also are areas of large biological production that can support a wide range of biological life. The generalized polynyas are shown in Figure 3.2.4-1.

Parkinson (2007) compiled average ice-concentration maps from April to November from 1997-2006 following the methods of Parkinson (2000). Figure 3.2.4-2 shows the average ice concentration over that period.

3.2.4.1. Beaufort Sea. Above is a description of the general ice types in the proposed Beaufort and Chukchi sales areas. Below are characteristics that are particular to the Beaufort sale area.

3.2.4.1.1. Seasonal Generalities. There are wide-ranging spatial and temporal variations of sea-ice formation and decay in the Beaufort Sea sales area; however, there is a general pattern:

- September-October, when shore ice forms; the river deltas freeze; and frazil, brash, and grease ice form within bays and near the coast. The Arctic pack ice begins reforming from its minimum extent and growing southward towards the Beaufort coast.
- Mid-October to November, when smooth, first-year ice forms within bays and near the coast. Thomas Napageak remarked: "...The critical months [for ice formation] are October, November, and December" (Napageak, as cited in Dames and Moore, 1996b:7).
- November through May, when the sea ice covers more than 97% of the Beaufort sales areas.
- Late May, when rivers flood over the nearshore sea ice.
- Late May to Early June when the river floodwaters drain from the surface of the sea ice. Sarah Kunaknana stated: "In June and July when the ice is rotting in the little bays along the coast" (Kunaknana, as cited in Shapiro and Metzner, 1979).
- Mid-June to early July, when floating and grounded landfast ice break up. The areas of open water with few icefloes expand along the coast and away from the shore, and pack ice migrates seaward. Vincent Nageak states: "The ice all along the coast on the mainland side of these islands rots early…" (Nageak, as cited in NSB, Commission on History and Culture, 1980). Samuel Kunaknana stated: "The ice goes completely out after July 4 around the Colville" (Kunaknana, as cited in Shapiro and Metzner, 1979).
- July-September when the Arctic pack ice recedes to its minimum position, and incursions of floating ice can move into the sales areas under northeast winds.

The relative locations of the ice edge during the time of maximum ice-free water in the Beaufort Sea are shown in Figure 3.2.4-3 for the period 1996 through 2007.

3.2.4.1.2. Beaufort Landfast Ice. Mahoney et al. (2007) describe three landfast ice zones in the Beaufort sales areas: (1) from Point Barrow to Barter Island; (2) Barter Island to Herschel Island; and (3) east of Herschel Island to Banks Island. Table 3.2.4-1 shows the mean and standard deviation of first ice, stable ice, breakup, and ice free in those three zones (Mahoney et al., 2007; Oasis Environmental and D.F. Dickens, 2006). The landfast ice in this region has its greatest extent in March and April except for zone 2, which is greatest in May (Mahoney et al., 2007). The width of the landfast ice averages from 6-80 km depending on the coastal location. The average landfast-ice thickness ranges from 33 cm in November to slightly over 200 cm in June (Vaudrey, 1996, 2000, as cited by Oasis Environmental and D.F. Dickens, 2006).

In the very nearshore zone and within the barrier islands once the landfast ice stabilizes, its movement is minimal up to a few hundred centimeters a day. Ice ridges initially form in about 8-15 m of water, but by late winter they may extend beyond the 20-m isobath. These ridges act as anchors that help stabilize the landfast ice (Eicken et al., 2006). In the eastern portion of the Beaufort, stable extensions of the landfast ice can form in deep water, when the pack ice is not energetic. These extensions generally are temporary and will break up with more energetic motion of the pack ice (Eicken et al., 2006, Oasis Environmental and D.F. Dickens, 2006).

3.2.4.1.3. Beaufort Stamukhi Ice or Shear Zone. In the Beaufort, ridges reach depths ranging from 18-25 m and act as sea anchors for the adjacent fast ice (Mahoney et al., 2007). The outer edge of the stamukhi zone advances seaward during the ice season.

The shear-ice zone also contains many leads. When offshore winds carry loose ice away from consolidated ice, there is a large lead that forms between the edge of the landfast ice and the pack ice

(Eiken et al., 2006). During the Beaufort Public Hearings in Nuiqsut, Mrs. Bessie Ericklook described what happens when a pressure ridge meets a barrier island:

> I have seen how a sodhouse was covered up by a pressure ridge in the wintertime. The wind was so strong that it covered one end of this island. The ice is very dangerous and unpredictable in Oct/Nov. During one December on one of the islands, another sodhouse was completely covered by pressure ridge. The ice had cracked and the ice turbulent and it took two of Tookak's kids. Another movement and his wife was taken away. You cannot talk of the ice so easily. You cannot control nature, the wind. The wind is the greatest factor (USDOI, BLM, 1979a).

3.2.4.1.4. Beaufort Pack-Ice Zone. During winter, movement in the pack-ice zone of the Beaufort Sea generally is small and tends to occur with strong winds of several days' duration. The long-term direction of ice movement is from east to west in response to the Beaufort Gyre; however, there may be short-term perturbations from the general trend due to the passage of low- and high-pressure weather systems across the Arctic. The velocity of the pack ice has been variously reported as having (1) a mean annual net drift of 1.4-4.8 km/day and (2) an actual rate of 2.2-7.4 km/day, with extreme events up to 32 km/day. East and northeast winds drive the ice offshore; westerly winds move the ice onshore.

Ridges are a prominent indicator of deformed pack ice. The height of most ridges appears to be about 1-2 m; ridge heights up to 6.4 m have been observed. The relationship between ridge-sail height and keel depths suggests a sail-to-keel ratio of about 1:4.5 for first-year ice ridges and 1:3.3 for multiyear ridges. Multiyear composite maps of major ridges indicate that: (1) in the nearshore region, there is a pronounced increase in ridge density in the vicinity of shoals and large promontories; (2) massive ridges occur shoreward of the 20-m isobath; and (3) in the eastern Beaufort Sea 30-40 km from the coast, there is an increase in ridging from east to west.

3.2.4.1.5. Leads and Open-Water Areas. Leads are areas of water between large pieces of ice. Data obtained from aerial and satellite remote sensing show that leads and open-water areas form within the pack-ice zone and particularly around the seaward landfast ice edge (Eicken et al., 2007). Southwesterly storms cause leads to form along this line in the Beaufort Sea. There is a distinct pattern of recurring leads in the western and west-central Beaufort Sea. Large-scale arc-shaped leads emanate from Point Barrow and also from a shoal off Harrison Bay. These leads separate a region of largely immobile ice in the southeastern Beaufort Sea from the more mobile pack ice in the west (Eicken et al., 2006).

3.2.4.1.6. Summer Ice Conditions. By the middle of July, much of the fast ice inside the 10-m isobath has melted; and there has been some movement of the ice. After the first openings and ice movement from late May to early June, the areas of open water with few icefloes expand along the coast and away from the shore, and there is a seaward migration of the pack ice. The concentration of icefloes generally increases seaward. During summer, winds from the east and northeast are common. These winds drive the ice offshore; westerly winds move the ice onshore. Elijah Kakinya noted: "In some years when the ice goes out in spring, it isn't visible in summer. Some years the ice goes out and comes back and is visible, and hangs around all summer months" (Kakinya, as cited in NSB, Commission on History and Culture, 1980). Elijah Kakinya stated: "In summer months, when there is a westerly wind, you can see ice from shore. But when the wind is blowing from northeasterly, the ice always goes out…you can't see any ice from shore" (Kakinya, as cited in NSB, Commission on History and Culture, 1980:152). Vincent Nageak stated: "…but in summer, huge ice chunks can pass the islands into Prudhoe Bay when the wind is from the west" (Nageak, as cited in NSB, Commission on History and Culture, 1980).

3.2.4.2. Chukchi Sea. Section 3.2.4 above contained a description of the general ice types in the Beaufort and Chukchi sales areas. Below are characteristics that are particular to the Chukchi sale area.

3.2.4.2.1. Seasonal Generalities. In the Chukchi sales area there also are large differences in timing from north to south, with the northern portions freezing first and melting last and the southern portions freezing last and melting first. Some generalizations follow.

Sea ice generally begins forming in late September or early October, covering most of the sale area by mid-November or the beginning of December (Brower et al., 1988; Belchansky, Douglas, and Platonov, 2004). On average, first-year or annual ice begins to melt earlier and freeze later than perennial or multiyear sea ice (Belchansky, Douglas, and Platonov, 2004). Melt-onset days begin in early May in the southern portion of the sale area and early to mid-June in the northern portion. Freeze onset begins in mid- to late October in the southern portion and late September to late October in the northern portion (Belchansky, Douglas, and Platonov, 2004).

By about mid-May, the nearshore ice and thin ice begin to melt; by July, the pack ice in the sale area begins retreating northward. Even in September when there is maximum open water, ice may be present in the northern sale area (Stringer and Groves, 1985). The relative locations of the ice edge during the time of maximum ice-free water in the Chukchi Sea are shown in Figure 3.2.4-4 for the period 1996 through 2007.

The general characteristics of sea-ice decay along the coast during summer are as follows: (1) over-ice flooding at the river mouths in spring; (2) meltpools forming on the ice surface; (3) openings in previously continuous ice sheets; (4) movements in previously immobile nearshore ice; and (5) nearshore areas largely free of fast ice. Because there are no major rivers along the Chukchi Sea coast, nearshore over-ice flooding is not a dominant component of the sea-ice-decay process.

The edge of the retreating pack ice is quite variable. In midsummer, the Chukchi Sea pack ice usually is composed of a mixture of broken, eroded blocks and small floes. The shape of the ice edge is irregular and includes embayments of various sizes that are produced by the melting action of warm water. Some of the larger embayments appear to recur from year to year in approximately the same places. One of the embayments occurs in the western Chukchi Sea between long. 170° and 175° W.; another embayment is centered at about long. 168° W.; and a third lies west to west-northwest of Point Barrow. These embayments are closely correlated with bathymetric troughs and support the concept that the flow of warm water from the Bering Sea is controlled, at least in part, by the bathymetry.

3.2.4.2.2. Chukchi Landfast Ice. The mean annual cycle of landfast ice begins in October and grows slowly through February. Freezing beings in late August to early September; first ice appears anywhere from late October to late December. Stable landfast ice appears from mid-January to mid-March. Thawing begins about late May, and breakup occurs from about late May to mid-June. Landfast ice in the Chukchi is not as stable as in the Beaufort. The landfast ice does not reach its final modal depth until April and, therefore, is not as stable as the central Beaufort, which reaches it modes in January and February (Eiken et al., 2006, 2007). The thickness of landfast ice, formed near Barrow, measured 1.67 + 1.0 m (Eiken et al., 2005)

Mahoney, Eicken, and Shapiro (2007) studied the development of landfast ice around Barrow. They report that distribution differences of the grounded ridges provide differences in anchoring strength, and suggest that ungrounded or weakly grounded ridges may decrease the overall stability of the landfast sea ice (Mahoney, Eicken, and Shapiro, 2007).

In the very shallow (2 m and less), inner part of the landfast zone, the ice freezes to the seafloor; in the outer part, the ice floats. Movement of ice in the landfast zone (called ice shoves, or *ivu* by the Inupiaq) is intermittent and may occur at any time but is more common during freezeup and breakup. Ice-shove motion is associated with several factors, including compaction of offshore sea ice, closure of coastal flaw lead, onshore winds, and warming of the landfast ice. The warming of the landfast ice reduces its strength and stability. Onshore winds are highly correlated with ice shoves.

Ice shoves and breakouts occur along the Chukchi coast. Ice shoves ranging from 5-395 m have been reported near Barrow (Shapiro, 1975; Huntington, Brower, and Norton, 2001; Mahoney et al., 2004; Talbott, 2006). The Elders believe that the current, not the wind, drives the *ivu* (Leavitt, as reported by Talbott, 2006). Breakouts can occur at any time of the year. Breakouts where the new landfast ice edge is within 1 km of the coast tend to occur most often at the end of the annual seasonal ice cycle (Blazey, Mahoney, and Eiken, 2005).

3.2.4.2.3. Chukchi Stamukhi Zone. In the Chukchi Sea, the region of most intense ridging occurs in waters that vary in depth from 15-40 m; moderate ridging extends seaward and shoreward of these regions.

Pressure and shear ridges are found within this region. Extensive sea-ice rafting usually occurs in the vicinity of pressure ridges, and ice thicknesses of two to four times the sheet thickness may be found within a few hundred meters of the ridge. Shear ridges are straighter, usually have one vertical side, and are composed of granulated-ice particles that range in size from a few centimeters in diameter up to rounded blocks that have dimensions comparable to the thickness in the ice that formed the ridge.

3.2.4.2.4. Chukchi Pack-Ice Zone. During winter, the pack ice in the northern part of the Chukchi Sea generally moves in a westerly direction due to the Beaufort Gyre and the prevalent atmospheric systems. There are short-term perturbations from the basic trend due to the passage of low- and high-atmospheric-pressure systems across the Arctic. Pack ice in the southern part of the Chukchi Sea usually is transported to the northeast or northwest. Breakouts, where ice forms an ice arch at Bering Strait and then fails, occur about two to four times a season and last for several (2-4) days (Pritchard, 1978; Colony, 1979; Pritchard, Reimer, and Coon, 1979; Lewbel, 1984).

Historically, first-year floes off the Chukchi Sea coast had a thickness of about 1.2-1.5 m, and multiyear floes were 3-5 m thick. Sea ice that is thicker than 5 m is common in the Arctic Ocean pack ice and generally is believed to consist of pressure ridges and rubble fields. Chukchi Sea ice cores measured in 2002 were 0.8-2.39 m, although ice type could not be readily determined (Eicken et al., 2005). As a result of melting and refreezing, multiyear ridges are stronger than first-year ridges. Other thick masses of sea ice include floebergs and ice islands. Floebergs are hummock or rubble fields that are frozen together. Ice islands are large, tabular icebergs with areal sizes ranging up to 1,000 km^2 or more and thicknesses up to 60 m (Sackinger et al., 1985).

Hanna Shoal is a site for the accumulation of ice features such as ice-island fragments or floebergs that have drafts >25 m (Toimil and Grantz, 1976; Eicken et al., 2006). Recurrent groundings of ice islands or floebergs result in the seasonal growth of this field.

3.2.4.2.5. Leads, Polynyas, and Flaw Zone. A system of seven recurring leads and polynyas develop within the Chukchi Sea. Figure III.A-14 in USDOI, MMS (2007d) shows their generalized location. Some polynyas develop between the landfast- and pack-ice zones extending the length of the Chukchi coast from Point Hope to Barrow during winter and spring adjacent to the Sale 193 area (Stringer and Groves, 1991). Between February and April, the average coastal lead-system width is <1 km (the extreme widths range from a few kilometers in February to 75-80 km in April) and is open about 50% of the time. Mean polynya widths range from 10-39 km and maximum from 18-151 km along the coast measured from 1990-2001 by Martin et al. (2004).

The Chukchi Sea has some of the largest areal fractions of leads along the northern coast of Alaska and Canada, due to the wind-driven polynyas that form along the coast from Point Hope to Barrow. Mean lead fractions range from 0.01-0.62 from Icy Cape to Point Barrow (Eiken et al., 2006), almost twice as much as the Beaufort Sea. There is a seasonal cycle in the lead fraction from a small fraction in winter to >10% in late spring. There is a transition from the linear leads in winter to the patches of open water surrounding flows in spring, and this is associated with an increase in the lead-density number typically occurring in late April (Eiken et al., 2006). Figure III.A-16 in USDOI, MMS (2007d) shows the monthly recurrence probability of leads. This figure shows prominent systems of leads or polynyas along the Alaskan Chukchi Sea coast.

Norton and Gaylord (2004) describe the Chukchi flaw zone in the months of March through June as a zone beyond the landfast ice that is 50-100 km or more wide. The ice flows in this area move independently from the arctic pack ice. These flows move southwest and northeast parallel to the coast and can reverse direction. Flows and pans can accelerate to high rates of speed if aligned to the shelf or Barrow Canyon.

The overall behavior of the Chukchi Sea open-water system from late spring to early fall is summarized as follows:

- During May and June, the average width is about 4 km at the northern end but widens to about 100 km at the southern end (there are, however, large variations in the width and the system is a more-or-less permanent feature).
- Through July and August, the average width increases dramatically (extreme widths of several hundred kilometers can occur), but the open-water system in the vicinity of Point Barrow and Wainwright may be closed.
- September is the period of maximum open water.
- The freezeback process begins in October.

3.2.4.2.6. Other Sea-Ice Processes. Sediment entrainment into sea ice is a recognized physical process that generally is limited to depths <30 m. Eicken et al. (2005) discuss two distinct mechanisms for incorporating sediments into sea ice in the Chukchi Sea region: (1) large polynya openings along the coast and (2) open-water areas outside of the landfast ice edge allow for the freezing of new ice and entrainment of sediments. Eicken et al. (2005) stress that the nature of these types of events are episodic and localized in nature. However, cumulatively the amount of sediment entrained into sea ice can be a significant amount. In addition, the amount of sediment load can affect the decay rate of sea ice by lowering the albedo of the ice and increasing the surface ablation rates (Frey et al., 2001).

Sea-Ice Drift. Drifting arctic sea ice plays a significant role in the redistribution of both sediments and contaminants (Pfirman et al., 1995, 1997). Based on a modeling effort in conjunction with arctic buoy data, drifting sea ice generally drifts from the polar basin to the Chukchi Sea during summer or from the Chukchi to the polar basin during summer (Pavlov, Pavlova, and Korsnes, 2004). Estimated travel time for sea ice from the Chukchi Sea to Fram Strait ranges from approximately 4-10.7 years based on travel times from Bering Strait and the Mackenzie River mouth.

3.2.4.3. Changes in Arctic Sea Ice. 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. 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. It generally is thought that the Arctic will be come ice free in the summer, but at this time there is considerable uncertainty about when that will happen. How these changes in sea ice affect ecosystems and its inhabitants are discussed in Sections 3.3 and 3.4.

Sea-ice extent predictions into the future, 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, 2006). Using a suite of models, a 40% loss is estimated for the Beaufort and Chukchi seas (Overland and Wang, 2007). 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 et al., 2008). Other investigators suggest that variability at the local and regional level is very important for making estimates of future changes. 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.

The analysis of long-term data sets indicate substantial reductions in both the extent (area of ocean covered by ice) and thickness of the arctic sea-ice cover during the past 20-40 years during summer and more recently during winter. Beginning in the 2000s, several record summer minimum extents were recorded in 2002, 2005, 2007, and 2008. On September 16, 2008 Arctic sea ice appeared to have reached its minimum (NSIDC, 2008). The 2008 sea ice minimum is slightly less the 2007 minimum but greater than the 2005 minimum. The 2008 minimum is the second-lowest minimum since 1979. Extreme minima were also recorded in 2003, 2004, and 2006 (Stroeve et al., 2005; NASA, 2005; Comiso, 2006, NSIDC, 2007). The September ice-extent trend for 1979-2006 declined by -8.4 % per decade (Meir, Strove, and Fetterer, 2007) and from 1979-2005 declined by -9.8% per decade (Comiso, 2006). After the September 14, 2007, record minimum, the trend for perennial ice extent and area is -10.2 and -11.4%, respectively (Comiso et al., 2008, Stroeve et al., 2008). The data show an increasing negative trend for sea ice extent and area from 2005-2007. The 2008 minimum ice extent continues the negative trend in summer time sea ice extent.

Within the background of the general decline of arctic sea-ice extent, the Chukchi and Beaufort seas have some of the largest declines in sea-ice extent during summer (Belchansky, Douglas, and Platonov, 2007; Perovich et al., 2007a) and an increase in the length of the sea-ice-free season in the Chukchi Sea (Belchansky, Douglas, and Platonov, 2005). From 1979-2006, Meier, Strove, and Fetterer (2007) found regional trends in percent per decade of -4.9% for the Chukchi and -1.2% for the Beaufort. Polyakov et al. (2003) studied the long-term variability of August ice extent from 1900-2001 and reported a -1 $\pm$ 0.9% decrease per decade for the Chukchi Sea. Lukovich and Barber (2007) report a maximum sea-ice concentration anomaly during the onset of ice formation occurred near the Beaufort and Chukchi during the late summer/early fall from 1979-2004.

The extent of winter sea ice, generally measured at the maximum in March, began changing in the late 1990s and has declined through 2006 (Comiso, 2006; Stroeve et al., 2007; Francis and Hunter, 2007). Comiso (2006) attributed the changes to corresponding changes in increasing surface temperature and wind-driven ice motion. The factors causing the reduction in the winter sea-ice extent may be different from those in summer. The reduction of the winter sea-ice extent in the Bering preconditions the environment during the melt season for the Chukchi Sea. The end of winter perennial sea-ice extent was the smallest on record in March 2007 (Nghiem et al., 2007a,b). The Arctic sea ice reached its maximum on March 10, 2008. Although the maximum was greater than 2007, it was still below average and was thinner than normal (Martin and Comiso, 2008; NSIDC, 2008).

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. Francis and Hunter (2006, 2007) suggest that downwelling longwave radiation fluxes account for approximately 40% of the variability of perennial sea-ice extent in the Beaufort and Chukchi sea area. Perovich et al. (2007b) demonstrate the importance of the ice-albedo feedback in explaining the large reduction of sea ice in the Western Arctic during the open-water period. The largest input was in the Chukchi Sea with as much as 4% per year.

In the Chukchi Sea, meridonal wind (one with a strong north-south component) also had an influence but played a lesser role in the Beaufort. Watanabe et al. (2006) suggest the Arctic dipole anomaly contributes to sea-ice export during its positive stage. Shimada et al. (2006) present evidence that the pattern of sea-ice extent is similar to the distribution of warm Pacific summer water. Kwok (2007, 2008) and Kwok, Maslowski, and Laxon (2005) identify and discuss the implications of multiyear-ice distribution, both in terms of an unusual outflow of multiyear ice into the Barents Sea and its consequences as a freshwater source to the transformation of Atlantic Water circulating in the Arctic.

Recent measurements and modeling show that the ice cover has continued to become thinner in some regions during the 1990s (Rothrock, Yu, and Maykut, 1999; Rothrock and Zhang, 2005). The annual mean ice draft decreased from a high of 3.42 m in 1980 to a minimum of 2.29 m in 2000 for the span of 1975-2000 (Rothrock, Percival, and Wensnahan, 2008). The average thinning of the ice appears to be the result of both the diminished fraction of multiyear ice and the relative thinning of all ice categories. Comparison of sea-ice draft data acquired on submarine cruises between 1993 and 1997, with similar data acquired between 1958 and 1976, indicates that the mean ice draft at the end of the melt season has decreased by about 1.3 m in most of the deep-water portion of the Arctic Ocean (from 3.1 m in 1958-1976 to 1.8 m in the 1990s [Yu, Maykut, and Rothrock, 2004]). The fractional coverage of first-year ice increased from <20% to 33%, respectively, between the two period (Yu, Maykut, and Rothrock, 2004). The decrease is greater in the central and eastern Arctic than in the Beaufort and Chukchi seas (Rothrock and Zhang, 2005).

The distribution of age class of ice in the Arctic has changed with less old ice and more new or first-year ice, which is consistent with the thinning of the ice cover. During the late 1980s and the early 1990s, a large portion of old ice (>10 years) was flushed out of the Arctic through Fram Strait (Rigor and Wallace, 2004). By the beginning of this decade, the loss of old pack ice continued and even increased. There was a 23% loss of arctic perennial sea ice from March 2005 to March 2007 (Nghiem et al., 2007a,b). Kwok (2007) found that the replacement of multiyear ice at the end of 2005 summer was near zero. He reports that from June through September 2005, the export through Fram Strait was the highest compared to a 7-year average from 2000-2006 (Kwok, 2007).

On the regional scale, there is a pronounced loss of old ice in the western Arctic at a rate of -4.2% annually and an increased prevalence of young ice through 2003 due to atmospheric circulation anomalies in the early 1990s (Belchansky, Douglas, and Platonov, 2005). The largest declines in multiyear-ice concentration (-3.3% year-1) occurred in the southern Beaufort and Chukchi seas (Belchansky, Douglas, and Platonov, 2004). The two prominent hypotheses on the loss of multiyear ice are the flushing factor through the Transpolar drift out of the Arctic (Kwok, 2004; Rigor and Wallace, 2004) and loss of multiyear ice with the addition of general rise in arctic temperatures (Rothrock and Zhang, 2005; Lindsay and Zhang, 2005; Francis et al., 2005). Hunters in Barrow have reported that the ice pack appears more diffuse in midsummer (Gearhead et al., 2006).

Changes in the landfast ice have been occurring. Hunters living in Barrow report the absence or rarity of old ice, thinner ice, shorefast breakoffs, and changing patterns of pressure-ridge formation and the stability of landfast ice (Gearhead et al., 2006). Events of shorefast ice breaking off have occurred near Barrow in January or February and even as late as March (George et al., 2003). These events also have increased in frequency. Polyakov et al. (2003) estimated that the long-term trends for fast-ice thickness in the Chukchi Sea were small from 1900-2000. Most of these data are from the Russian side of the Chukchi Sea. Through modeling studies, Dumas, Carmack, and Melling (2005) postulate that air temperature and snow accumulation are a large factor in determining the duration of landfast ice in the Beaufort Sea.

As air temperature rises, landfast-ice duration is shorter, melting out approximately a month earlier in the Beaufort and 2 weeks earlier in the Chukchi (Mahoney et al., 2007). An earlier onset date of thawing in spring is responsible for the earlier breakup of landfast ice in the Beaufort and Chukchi seas (Eiken et al., 2006; Mahoney et al., 2007).

The analysis of melt and freeze dates to describe the melt-season duration were estimated from 1979-2001. Following the AO high-index phase in the late 1980s and early 1990s, the melt duration increased 2-3 weeks in the Chukchi (Belchansky, Douglas, and Platonov, 2004). Although freeze distributions have re-established to the low AO index phase patterns, the melt distributions have not (Belchansky, Douglas, and Platonov, 2004).

The Arctic sea ice is in transition. Since the mid-1960s, temperature increases in the atmosphere lead to a reduced ice cover. As the ice melts, more solar radiation is absorbed heating the surface of the ocean. Sea-surface temperature anomalies from both the Pacific and Atlantic are increasing in the Arctic. The amount of heat entering the Arctic is increasing both from sunlight and circulation, which helps to melt sea ice. The area of thick ice that once covered the entire arctic basins now is limited to portions near Greenland and the islands of the Canadian High Arctic. As the sea ice thins, less ice lasts through the summer melt period. The sea-ice extent currently observed is outside of the range of the climate-model forecasts. There are important mechanisms and processes that are not clearly understood. There is agreement that there will be ice-free summers in the future (2013-2050), but when that will happen cannot be estimated with certainty.

3.2.5. Water Quality.

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. The constituents of water in the marine environment mainly are composed of naturally occurring substances derived from the atmospheric, terrestrial, and other aquatic (freshwater and marine) environments. However, the constituents may include manmade substances and a few naturally occurring ones at toxic concentrations—pollutants.

3.2.5.1. Pollutants. The principal sources of pollutants entering the marine environment in general include discharges from industrial activities (petroleum industry) and accidental spills or discharges of crude or refined petroleum and other substances. Because of limited municipal and industrial activity around the Arctic Ocean coast, most pollutants occur at low levels in the Arctic. The rivers that flow into the Alaskan arctic marine environment remain relatively unpolluted by human activities, but they carry into the marine environment suspended sediment particles with trace metals and hydrocarbons. Winds and drifting sea ice may play a role in the long-range redistribution of pollutants in the Arctic Ocean. The broad arctic distribution of pollutants is described in a report by the Arctic Monitoring and Assessment Program (AMAP, 1997) entitled *Arctic Pollution Issues: A State of the Arctic Environmental Report*.

3.2.5.1.1. Hydrocarbons. Crude oil is composed mainly of hydrogen and carbon with minor amounts of sulfur, nitrogen, and oxygen; heavy metals such as vanadium also may be present. These elements form a variety of hydrocarbon compounds. Crude oil and coal are complex mixtures of saturated, polynuclear aromatic and other hydrocarbons. Saturated hydrocarbons, paraffins, and naphthenes, are the most common constituents of crude oil.

Background hydrocarbon concentrations in Beaufort Sea water appear to be biogenic and are on the order of one part per billion (ppb) or less (Trefry et al., 2004). The hydrocarbons analyzed in the Beaufort Sea sediments include total resolved and unresolved saturated hydrocarbons (n-C9 through n-C40), polynuclear aromatic hydrocarbons, and triterpanes. Polynuclear aromatic hydrocarbons (PAHs) are composed of organic compounds from fossil fuels (coal and petroleum), biogenic processes, and pyrogenic or combustion sources. Pyrogenic sources include incomplete combustion of fossil fuels (internal combustion engine), other organic matter such as wood (forest fires) or trash, and volcanic activity. Pyrogenic polynuclear aromatic hydrocarbons are found in the atmosphere and widespread environmental contaminants. Triterpanes are derived from petroleum or biogenic sources.

Total Organic Carbon. Total organic carbon content of the sediments that were sampled in 1999 as part of the Arctic Nearshore Impact Monitoring in Development Areas (ANIMIDA) Program ranged from 0.01% in the sandy sediment near the Northstar Island to 3.42% in the mud-rich sediment near the nearshore (Boehm, 2001). The mean concentration was 0.62%. Total organic content in these samples is typical of arctic shelf sediment. The variation in the total organic content of the surficial sediments is related to grain size.

Saturated Hydrocarbons. For most Beaufort Sea stations, the total saturated hydrocarbon concentrations are low, ranging from 0.21-16 milligrams per kilogram (mg/kg) (Boehm, 2001). These hydrocarbons are a mixture of terrestrial plant waxes with lower levels of petroleum hydrocarbons.

Samples of river sediments and peat have total saturated hydrocarbon values of 5.8-36 mg/kg and 21-32 mg/kg, respectively (Boehm, 2001). Sediments were sampled in the Colville, Kuparuk, and Sagavanirktok rivers. Peat samples came from areas along the Colville and Kuparuk rivers. The compositions of saturated hydrocarbons in the river and peat samples were similar to the composition in Beaufort Sea surficial sediments. This similarity indicates a common source of saturated hydrocarbons for river sediments and nearshore surficial sediments.

The highest total saturated hydrocarbon value, 50 mg/kg, for this suite of samples was found at the station west of West Dock in Prudhoe Bay (Boehm, 2001). The sample from this station contained high concentrations of metals and indicated contamination from an anthropogenic source.

Polynuclear Aromatic Hydrocarbons. The PAH levels are within the range of values reported from previous studies in the Beaufort Sea and other areas (Boehm, 2001). The PAHs in most of the sediment samples were derived from petrogenic/fossil fuel (petroleum and coal), biogenic (perylene), and pyrogenic sources. The station located west of West Dock had the highest PAH concentration, 2,700 microgram per kilogram (µg/kg). This site also had a higher concentration of a number of the trace metals than did other sites. The high concentrations of PAHs indicate possible hydrocarbon contamination.

Boehm (2001) noted an increase in the ratios of pyrogenic to petrogenic PAHs between the samples collected from the same stations in 1989 and 1999; the mean ratios were 0.038 in 1989 and 0.096 in 1999.

Total PAH values for the station samples in 1999 are much lower than the Effects Range-Low (ERL) concentration, 4,022 µg/kg (Long and Morgan, 1990); this includes the station west of West Dock. Boehm (2001) noted that PAH concentrations in the sediments sampled did exceed the ERL for the 13 individual PAH compounds for which these values have been developed. Boehm (2001) concluded that the PAH concentrations in the study area sediment are not likely to pose an immediate ecological risk to marine organisms in the area.

In 1997, Naidu et al (2001) sampled nearshore Beaufort Sea surface sediments to determine if there were any significant changes in the concentrations of selected trace metals and hydrocarbons as the result of ongoing oil and gas development between the Colville and Canning rivers. Of the 21 stations sampled, 20 were at the same locations occupied as part of the Beaufort Sea Monitoring Program previously mentioned.

The hydrocarbons in the sediments sampled in 1997 (Naidu et al., 2001) consist of a mixture of organic matter of marine and terrestrial origin. The total saturated hydrocarbons range from about 201-12,498 nanograms per gram (ng/g) and are largely characteristic of biogenic sources. The low-molecular-weight saturated hydrocarbons are derived mainly from marine sources, and the high-molecular-weight saturated hydrocarbons come mainly from plant waxes in the coastal peats and possibly from coal residues. The PAH assemblages in the sediments are very similar to those observed in coastal peats and river sediments. The concentrations of total PAHs range from about 21-2,185 ng/g.

Other Hydrocarbons. The surface samples also were analyzed for pesticides, polychlorinated biphenyls, semivolatile organic compounds, and selected volatile organic compounds. The presence of these substances either could not be detected, which occurred for the majority of the samples, or their concentrations were within a low range that was influenced by the detection method, and the amounts were presented as estimates.

3.2.5.1.2. Trace Metals. Beaufort Sea trace metals were sampled as part of the Beaufort Sea Monitoring Program. The samples were analyzed by Boehm, and the results are summarized in the Liberty final EIS (USDOI, MMS, 2002b). Beaufort Sea sediments also were sampled in August 1999 as part of the ANIMIDA Program and analyzed for trace metals (Boehm et al., 2001). The sampling program included 15 stations that were part of the Beaufort Sea Monitoring Program. Six of the stations were in the southeastern portion of Stefansson Sound, five stations were located near the site of the Northstar development project, and four stations were located between the two areas. In addition, samples were collected at 12 new stations in Stefansson Sound and 15 new stations around the Northstar Island. The concentrations of the metals in the marine sediments are comparable to the concentrations of those metals that have been analyzed in the past. Also, all the concentrations are below known Effects Range-Median (ERM) concentrations, and most are below known ERL concentrations.

Naturally occurring levels of trace metals in the surface sediments vary with sediment grain size, organic carbon content, and mineralogy (Boehm et al., 2001). In general, sediments consisting mainly of fine-grained (silt- and clay-size) particles contain more organic carbon and trace metals than sediments in which sand-, gravel-, and larger-size particles predominate. Compared to coarser grain particles, fine-grain particles have a larger active surface area available for adsorption of matter containing organic material or trace metals. Aluminum, or iron, can be used to normalize other metal values to offset variations caused by differences in grain size, organic carbon content, or mineralogy (Boehm et al., 2001). Aluminum rarely is introduced into the environment by anthropogenic process.

Normalizing metal concentrations with aluminum can be done to indicate possible contamination from past events or to identify potential sources of contamination and contaminated sites in the future. This technique was used by Boehm et al. (2001) to indicate possible contamination of marine sediments in the Beaufort Sea.

Normalizing barium concentrations with aluminum provides an example of this technique (Boehm et al., 2001). Barium is found in the earth's continental crust in relatively high concentrations (the average is 584 μg/g) (Wedepohl, 1995, as reported in Boehm et al., 2001); by comparison, the average concentration of copper in the continental crust is 25 μg/g. Concentrations of barium in the 1999 sediment samples ranged from 173-753 μg/g; copper concentrations ranged from 4.0-46.9 μg/g. Barium is a component of the naturally occurring mineral barite, and this compound is used in drilling muds. In the past, drilling muds have been discharged into the Beaufort Sea and could be discharged accidentally in the future.

Boehm et al. (2001) normalized other metal concentration with aluminum. Plots for aluminum versus both chromium and vanadium did not show any discernible anthropogenic inputs of these metals. Plots for aluminum versus copper, lead, cadmium, silver, arsenic, antimony, nickel, mercury, and cobalt showed anomalous values for these metals at a station located about 1.5 km west of West Dock in Prudhoe Bay. Compared to all the stations sampled in 1999, the station near West Dock had the highest concentrations for all these metals except antimony. This site is near an area of high construction and development activity. The sediment from this site also had higher total saturated hydrocarbon and PAH concentrations than any other site sampled.

One way to evaluate potential trace-metal contamination in sediments, and possible effects on biota, is to compare the sediment values with ERL and ERM values developed by Long and Morgan (1990) for sediment-sorbed contaminants. All the metal concentrations in the sample from the site west of West Dock, except for nickel and mercury, are below the ERL for the respective metals; the concentrations for nickel and mercury were below the ERM.

As previously noted, Naidu et al. (2001) sampled nearshore Beaufort Sea surface sediments to determine if there were any significant changes in the concentrations of selected trace metals as the result of ongoing oil and gas development between the Colville and Canning rivers. Of the 21 stations sampled, 20 were at the same locations occupied as part of the Beaufort Sea Monitoring Program that was mentioned in the previous paragraphs. The concentrations of the trace metals in the sediments sampled in 1997 (Naidu et al., 2001) are similar to the concentrations observed by other studies. Naidu et al. (2001) noted the concentrations of barium and vanadium were higher in the samples collected in 1997 compared to earlier samples, but the reasons for the differences are unknown. The levels of barium and vanadium are below or comparable to the values reported for unpolluted nearshore marine sediments (Naidu et al., 2001).

Dissolved and particulate trace-metal concentrations in the open-waters of the Beaufort Sea were determined for samples collected each summer between 2000 and 2006 as part of the continuation of the ANIMIDA Program (cANIMIDA) (Trefry et al., 2008). Concentrations of particulate metals show interannual variability due to differences in the composition of the suspended sediment. The average concentrations of trace metals in suspended sediment were found to be higher than those found in bottom sediments, because the bottom sediments contain more quartz sand and carbonate shell material that dilutes the trace metal concentrations. Concentrations of dissolved trace metals were found to be well below the Environmental Protection Agency (EPA) water quality criteria for chronic impacts in marine waters.

Trace metal concentrations in the Chukchi are elevated compared to those in the eastern portions of the Arctic Ocean. The higher concentrations are thought to come from Bering Sea water that passes first through the Chukchi Sea and then through the Beaufort Sea (Moore, 1981; Yeats, 1988). These waters, however, still are considerably lower in trace metal concentrations than the EPA criteria for the protection of marine life (Boehm et al., 1987; Crecelius et al., 1991; USDOI, MMS, 1996a,b).

3.2.5.1.3. Turbidity. Turbidity in the Beaufort Sea is very different during the summer open-water period as opposed to the winter ice-covered period.

Summer - Open Water. Turbidity is caused by fine-grained particles suspended in the water column. These particles come from rivers discharging into the marine environment, coastal erosion, and resuspension by wave action of particles deposited on the seafloor. Turbid waters generally are found at depths <16 ft (5 m) deep and do not extend seaward of the barrier islands (Trefry et al., 2008).

In mid-June through early July, the shallow, inshore waters generally carry more suspended material, because runoff from the rivers produces very high turbidity adjacent to the river mouths. Deltas at the mouths of rivers indicate deposition of river-borne sediments. Total suspended solids in the Sagavanirktok River during summer 2004, 2005 and 2006 ranged from 0.5-53.4 milligrams per liter (mg/L) (Trefry et al., 2008). Maximum values corresponded to midseason river-discharge peaks following large rainfall events in the Brooks Range. The highest levels of suspended particles in the Sagavanirktok River discharge are found during breakup; maximum values ranged from 285-609 mg/L for 2001-2006 (Trefry et al., 2008). The turbidity resulting from the floods, along with other factors, block the light and measurably reduce primary productivity of shallow, coastal waters (Dunton et al., 2004).

Winter - Ice Covered. In winter, the amount of suspended sediments under the sea ice ranged from 2.5-76.5 mg/L in the southeastern portion of Stefansson Sound (Montgomery Watson, 1997, 1998). Total suspended solids (TSS) in the water from beneath the ice in Gwydyr Bay ranged from 7,480-26,920 mg/L and from off Stump Island ranged from undetectable to 885 mg/L (Montgomery Watson, 1996, as reported in U.S. Army Corps of Engineers, 1998). Gwydyr Bay is located west of the Sagavanirktok River.

In April 2000, as part of the ANIMIDA project, the concentrations of suspended particulate matter (SPM) at various depths in the water column under about 2 m of ice were determined from water samples collected from stations in the vicinity of the Endicott development island, the Northstar Island (development project), and in Foggy Island Bay (Boehm et al., 2001; Weingartner and Okkonen, 2001). The amounts of suspended sediments in the water samples were determined by the same laboratory methods. The TSS measurements ranged from 0.14-0.58 mg/L; turbidity measurements ranged from 0.15-0.70 nephelometric turbidity units (Boehm et al., 2001). These concentration ranges were lower than the concentrations of SPM in the water column in August 1999.

The concentrations of particulate matter in ice cores were determined from seven stations located in the vicinity of the Endicott and Northstar developments. The total suspended-sediment concentrations in these ice cores ranged from 1.25-248 mg/L (Boehm et al., 2001). In general, the concentrations of particulate matter decrease with depth in the ice core. Ice forms on the surface of the water and traps any SPM present in the water. The amount of SPM depends on the meteorological and oceanographic conditions at the time. Storms in late fall could result in higher concentrations of SPM than if conditions were calm during freezeup. When the surface freezes, the generation of waves and currents in response to winds decreases, and there is less energy in the water column. As the energy decreases, the capability of the water to retain particles in suspension lessens. Settling of particles decreases the concentration in the upper part of the water column. As the ice forms deeper in the water, the concentrations of SPM have decreased, and there is less material to entrap in the ice.

Water quality also is affected by natural erosion of organic material along the shorelines. The Chukchi is a high-energy shore once the ice is gone. Erosion and flooding occur with autumn and spring storms and ice movement. The increased oxygen demand of these inputs marginally may lower oxygen levels and locally increase turbidity. These effects usually occur in waters <5 m deep. Another cause of altered water quality is sea-ice cover. As sea ice forms during fall, particulates are removed from the water column by ice crystals and are locked into the ice cover. The result is very low-turbidity levels during winter.

3.2.5.2. Current and Anticipated Effects of Climate Change. Climate change can affect water quality through different mechanisms. Loss of sea ice has led to increased wave activity and accelerated erosion along the Arctic coast, causing increased turbidity and resulting in exposure of municipal and military dumps, as well as legacy oil wells. Any changes in precipitation rates would affect stream flow and runoff; hence, turbidity levels and transport of contaminants. Increases in the frequency and/or severity of storms also would increase turbidity.

Climate change also will lead to altered water chemistry. In particular, the average pH of the surface ocean is projected to decrease by as much as 0.4 pH units by 2100 due to the uptake of excess carbon dioxide (European Science Foundation, 2008). In addition, higher water temperatures result in increased biological production and decomposition. The increased respiration rates can lead to reduced dissolved oxygen levels.

3.2.5.3. Existing Regulatory Control of Discharges, Dredging, and Filling. The principal method for controlling pollutant discharges is through Section 402 (33 U.S.C. § 1342) of the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act of 1972 [CWA]), which establishes a National Pollution Discharge Elimination System (NPDES) (Laws, 1987). Under Section 402, the EPA or authorized states can issue permits for pollutant discharges, or they can refuse to issue such permits if the discharge would create conditions that violate the water-quality standards developed under Section 303 (33 U.S.C. § 1313) of the CWA. The CWA, Section 403 (33 U.S.C. § 1343), states that no NPDES permit shall be issued for a discharge into marine waters except in compliance with established guidelines.

The guidelines require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment (40 CFR 125.122). Unreasonable degradation of the marine environment means: (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities; (2) threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or (3) loss of aesthetic, recreational, scientific, or economic values, which is unreasonable in relation to the benefit derived from the discharge.

The general NPDES permit AKG280000 (EPA, 2006b) for the offshore areas of Alaska located in the Beaufort Sea, Chukchi Sea, Hope Basin, and Norton Basin 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. This permit does not apply to development and production facilities, which require individual permits.

Since 1973, discharges incidental to the normal operation of vessels have been excluded from NPDES permitting requirements. However, a recent court order has revoked 40 CFR § 122.3(a), the regulation excluding these discharges, effective December 19, 2008. Current USCG regulations related to pollution prevention and discharges for vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water are found at 33 CFR § 151.

The latest information on water-quality standards for the EPA is available in the current edition of 40 CFR § 131 or at the agency's internet web site (www.epa.gov). State of Alaska water quality information is available in the most recent version of 18 AAC 70 or at the Alaska Department of Environmental Conservation (ADEC) web site (www.state.ak.us/dec/).

3.2.6. Air Quality.

The EPA has established National Ambient Air Quality Standards (NAAQS) for six "criteria pollutants" to provide protection from adverse effects on human health and welfare. These standards set a limit to the concentration of these pollutants in the ambient air. When an area does not meet the air quality standard for one of the criteria pollutants, EPA designates it as a nonattainment area. The Clean Air Act (CAA) sets forth the regulatory process to be applied to an area to comply with the standards by a designated date. This date varies by the type of pollutant and the severity of the problem.

The air quality of coastal areas adjacent to the Beaufort Sea and Chukchi Sea is relatively pristine with pollutant concentrations well within the national and State AAQS (18 AAC 50). The whole area is classified attainment under the CAA. Table 3.2.6-1 lists the applicable national and State AAQS.

Air emissions from OCS facilities in the Beaufort Sea and Chukchi Sea would be regulated by the EPA, which has jurisdiction for OCS air quality as prescribed in 40 CFR Part 55. For facilities located within 25 mi (40 km) of the State seaward boundary, the air quality regulations would be the same as if the emission source were located onshore and, thus, the State of Alaska regulations would apply. For facilities located beyond 25 mi (40 km) of the State seaward boundary, the basic Federal air quality regulations apply. These would include the EPA New Source Performance Standards and Prevention of Significant Deterioration (PSD) regulations.

3.2.6.1. Local Industrial Emissions. Over most of the onshore area adjacent to the Chukchi Sea, there are only a few small, scattered emissions from widely scattered sources. There are no significant industrial emission sources in close proximity to the Chukchi Sea Planning Area. The nearest significant industrial source is the Red Dog Mine, approximately 125 mi (200 km) southeast of the southern boundary of the planning area.

In the Beaufort Sea area, there are significant sources of industrial emissions located at the Prudhoe Bay/Kuparuk/Endicott oil production complex. The Prudhoe Bay oilfield was the subject of monitoring programs during 1986-1987 (ERT Company, 1987; Environmental Science and Engineering, Inc., 1987) and from 1990 through 1996 (ENSR, 1996, as cited in U.S. Army Corps of Engineers, 1999). Five monitoring sites were selected—three were considered subject to maximum air-pollutant concentrations and two were considered more representative of the air quality of the general Prudhoe Bay area. The observations for the period 1990-1996 are summarized in Table 3.2.6-2. The maximum 24-hour particulate matter <10μ in diameter (PM_{10}) measurement at one of the stations exceeds the NAAQS of 150 micrograms per cubic meter ($\mu g/m^3$); however, a violation only occurs if the 99^{th} percentile of the measured concentrations exceeds this value. Therefore, all values meet the national and State AAQS. The measurements also show that the PSD Class II increments are being met, even without taking into account natural background or baseline values. There are no measurements of fine particles ($PM_{2.5}$) for the Arctic Ocean coastal area. The EPA classifies the area as unclassifiable/attainment for $PM_{2.5.}$

3.2.6.2. Arctic Haze. Although measurements indicate that the air quality standards are being met throughout the Alaskan Arctic, human observations have appeared to indicate that atmospheric visibility is sometimes impaired by atmospheric contaminants. For example, Hattie Long stated: “We get a lot of yellow haze out of Prudhoe all year long…since the time that the haze started hovering over Nuiqsut” (U.S. Army Corps of Engineers, 1996).

The phenomenon of arctic haze, which occurs in northern Alaska in winter and spring, is attributed primarily to long-range transport of pollutants from sources on the Eurasian continent (ADEC, 2002; Rahn, 1982). The composition of the aerosols producing regional haze consists of approximately 90% sulfate aerosols and 10% soot (Wilcox and Cahill, 2003). Europe and Russia appear to be the main contributors of long-range transport of sulfur and fine particles to the Arctic. Maximum concentrations of some pollutants, sulfates and fine particles, were observed during the early 1980s. Observers measured decreases at select stations at the end of the 1980s (Pacyna, 1995). This decline in atmospheric sulfur in the Arctic was due to a downward trend in emissions. Reductions in Europe have occurred as a result of improvements in environmental practices. Decreased sulfur emissions in Russia have occurred because of increased use of natural gas for fuel rather than coal, as well as a sharp economic downturn that followed the dissolution of the Soviet Union. However, the decline in emissions from Russia may be reversing as a consequence of economic revitalization and an increasing reliance on coal as natural gas becomes more valuable for export (Wilcox and Cahill, 2003).

Pollutant sulfate due to arctic haze in the air in Barrow (that in excess of natural background) averages 1.5 $\mu g/m^3$. The concentration of vanadium, a combustion product of fossil fuels, averages up to 20 times the background levels in the air and snow pack. Recent observations of the chemistry of the snow pack in the Canadian Arctic also provide evidence of long-range transport of small concentrations of organochlorine pesticides (Gregor and Gummer, 1989). Concentrations of visibility-reducing atmospheric contaminants during winter and spring at Barrow are similar to those over large portions of the continental United States, but they are considerably higher than levels south of the Brooks Range in Alaska. Any ground-level effects of arctic haze on the concentrations of regulated air pollutants in the Prudhoe Bay area are included in the monitoring data given in Table 3.2.6-2. Model calculations indicate that <10% of the pollutants emitted in the major source regions are deposited in the Arctic (Pacyna, 1995). Despite this seasonal, long-distance transport of pollutants into the Arctic, regional air quality still is far better than the ambient standards.

3.2.7. Sound.

Natural sound in the project area predominantly originates from the action of wind, waves, and ice and biological activity (see Richardson et al., 1995a: Chapter 5). There is a background or ambient level of natural sound. Ambient-sound levels of natural sound can vary dramatically between and within seasons at a particular site and vary 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 (dB re 1 μPa, these units are described below).

Anthropogenic or human-caused sources of sound in the project area include vessels (motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc.); navigation and scientific research equipment; airplanes and helicopters; human settlements; military activities; and marine development. In addition to variations in natural sounds, levels of anthropogenic sound can vary dramatically depending on the number community and industrial shipping, research, and subsistence activities.

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. We considered most human-generated sounds to be noise. For example, all sounds from aircraft are considered noise.

3.2.7.1. Sources of Natural Sound in the Alaskan Arctic. The primary sources of natural sound in the Arctic include sea ice, wind and waves, and marine mammals. Most of these sounds affect the marine environment.

3.2.7.1.1. Sea Ice. The presence of ice can contribute significantly 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 significant 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 (Richardson et al, 1995a). 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 significant thermal cracking sounds (Milne and Ganton, 1964). In areas characterized by a continuous 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)-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. The NRC (2001, citing Urick, 1984) 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). As icebergs melt, they produce additional background sound as the icebergs tumble and collide.

The presence, thickness, and movement of sea ice significantly influence the ice's contribution to ambient sound levels and the period of open water when wind and waves contribute to ambient sound levels. Available evidence indicates that the total extent of arctic sea ice has declined over the past several decades; these declines are not consistent across the Arctic (Gloersen and Campbell, 1991; Johannessen, Miles, and Bjorgo, 1995; Maslanik, Serreze, and Barry, 1996; Parkinson et al., 1999; Vinnikov et al., 1999). Warming trends in the Arctic (Comiso, 2003) appear to be affecting thickness of multiyear ice in the polar basin (Rothrock, Yu, and Maykut, 1999) and perennial sea-ice coverage (declines 9% per decade) (Comiso, 2002a,b). See Sections 3.2.4.3 (Changes in Arctic Sea Ice) and 3.2.2.5 (Changes in the Arctic) for additional climate change information.

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 noise into the marine environment. Because of sea ice and its effects on human activities, ambient sound levels in the Beaufort and Chukchi seas can vary dramatically between seasons and sea-ice conditions. The presence of ice also impacts which marine species are present, another factor that influences ambient sound levels.

If arctic warming continues, it is likely that changes in the acoustic environment also will occur in many parts of the waters off Alaska (Tynan and DeMaster, 1997; Brigham and Ellis, 2004). Climate warming potentially could (a) increase noise and disturbance related to increased shipping and other vessel traffic, and possibly increased seismic exploration and development; (b) expand commercial fishing and/or cause a change in areas where intensive fishing occurs; (c) decrease year-round ice cover; (d) change subsistence-hunting practices; and (e) change the distribution of marine mammal species (MacLeod et al., 2005).

3.2.7.1.2. Wind and Waves. In the Arctic, wind and waves (during the open-water season) are important sources of ambient sounds with levels tending to increase with increased wind and sea state, all other factors being equal (Richardson et al. 1995a). The marginal ice zone, in 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 icefloes (Milne and Ganton, 1964).

3.2.7.1.3. Marine Mammals (and Birds). At least seasonally, marine mammals can contribute significantly to the background sounds in the acoustic environment of the Beaufort and Chukchi seas. Frequencies and levels are highly dependent on seasons. For example, source levels of bearded seal songs have been estimated to be up to 178 dB re 1 µPa at 1 m (Cummings et al., 1983). Ringed seal calls have a source level of 95-130 dB re 1 μPa at 1 m, with the dominant frequency under 5 kHz (Richardson et al., 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 μPa at 1 m in frequency ranges from 20-3,500 Hz. Richardson et al. (1995a) summarized that most bowhead whale calls are "tonal frequency-modulated (FM)" 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, potentially but less likely, the humpback whale. Walrus, seals, and seabirds (especially in the Chukchi Sea near colonies), all produce sound that can be heard above water.

3.2.7.2. Sources of Anthropogenic Sound. The primary sources of anthropogenic sounds in the Arctic include vessel activities and traffic, oil and gas exploration and development operations, and other miscellaneous activities. During much of the year in many marine areas in the action area, there are few near-field marine-noise sources of human origin and limited, but increasing, land-based and nearshore-based sources of noise.

Sounds in the Arctic are propagated into a marine environment that already receives sounds from numerous other human and natural sources. Human sources include noise from vessels (motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc.); navigation and scientific research equipment; airplanes and helicopters; human settlements; military activities; and marine development, including those from the oil and gas industry. Table 3.2.7-1 provides a comparison of manmade sound levels from various sources associated with the marine environment.

3.2.7.2.1. Vessel Activities and Traffic. Shipping noise, often at source levels of 150-190 dB re 1 μPa, has, since 1950, contributed a worldwide 10- to 20-dB increase in the background sound levels in the sea (Andrew et al., 2002; Acoustic Ecology Institute, 2005; McDonald et al., 2006). The types of vessels that typically produce noise in the Beaufort and Chukchi seas 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, summer, and early autumn.

In shallow water, vessels more than 10 km away from a receiver generally contribute only to background-noise levels (Richardson et al., 1995a). In deep water, traffic noise up to 4,000 km away may contribute to background-noise levels (Richardson et al., 1995a). Shipping traffic is most significant at frequencies from 20-300 Hz (Richardson et al., 1995a). 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 (Richardson et al., 1995a).

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 (Richardson et al., 1995a). 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 (Richardson et al., 1991). In some instances, icebreaking sounds are detectable from more than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995a).

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

3.2.7.2.2. Noise Generated by Oil and Gas Activities. Noise from oil and gas exploration and development activities include seismic and other related industry activities.

Seismic Noise. The oil and gas industry in Alaska conducts marine (open-water) surveys in the summer and fall and on-ice seismic surveys in the winter to locate geological structures potentially capable of containing petroleum accumulations and to better characterize ocean substrates or sub-sea terrain. During a typical open-water seismic survey, an airgun array is towed behind a vessel at 4- 8-m depth and is fired every 10-15 seconds. These surveys use individual airguns, or a combination of individual airguns called an airgun array, to produce sound waves that typically are aimed directly at the seafloor. The ship also may be towing long cables with hydrophones (streamers), which detect the reflected sounds from the seafloor.

The sound for seismic surveys is created by the venting of high-pressure air from the airguns into the water column and the subsequent production of an air-filled cavity (a bubble) that expands and contracts, creating sound with each oscillation. Airgun output usually is specified in terms of zero-to-peak or peak-to-peak levels. Airgun sizes are quoted as chamber volumes in cubic inches in^3, and individual guns may vary in size from a few tens to a few hundreds of cubic inches. Airgun volumes associated with high-resolution surveys typically are 90-150 in^3 and the output of a 90-in^3 airgun ranges from 229-233 dB re 1μPa at 1m.

Airgun-array sizes are quoted as the sum of their individual airgun volumes and again can vary greatly. The array output is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. commun.). For single airguns, the zero-peak acoustic output is proportional to the cube root of the volume. As an example, compare two airgun configurations with the same total volume. The first array consists of one airgun with a total volume of 100 in^3 resulting in a cube root of 4.64. The second array has the same total volume, but consists of five 20-in^3 guns. The second array has an acoustic output nearly three times higher (5 times the cube root of 20 = 13.57) than the single gun, while the gun volumes are equal. The output of a typical two-dimensional/3-dimensional (2D/3D) array has a theoretical point-source output of ~255 dB $\underline{+}$ 3 dB (Barger and Hamblen, 1980; Johnston and Cain, 1981); however, this is not realized in the water column, and maximum real pressure is more on the order of 232 dB ± 3 dB and typically only occurs within 1-2 m of the airguns. Seismic sounds vary, but a typical 2D/3D seismic survey with multiple guns would emit energy at about 10-120 Hz, and pulses can contain energy up to 500-1,000 Hz (Richardson et al. 1995a). Goold and Fish (1998) recorded a pulse range of 200 Hz-22 kHz from a 2D survey using a 2,120-in^3 array.

The depth at which the source is towed has a major impact on the maximum near-field output, and on the shape of its frequency spectrum. The rms received levels are not directly comparable to the peak or peak-to-peak values normally used to characterize source levels of airguns. The measurement units used to describe airgun sources, peak or peak-to-peak decibels, are always higher than the root-mean-square (rms) decibels referred to in much of the biological literature. A measured received level of 160 dB rms in the far field typically would correspond to a peak measurement of about 170-172 dB, and to a peak-to-peak measurement of about 176-178 dB, as measured for the same pulse received at the same location (Greene, 1997; McCauley et al., 1998, 2000). The precise difference between rms and peak or peak-to-peak values for a given pulse depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source.

Tolstoy et al. (2004) collected empirical data concerning 190-, 180-, 170-, and 160-dB (rms) distances in deep (~3,200 m) and shallow (~30 m) water for various airgun-array configurations during the acoustic-calibration study conducted by Lamont-Doherty Earth Observatory in the northern Gulf of Mexico. Results demonstrate that received levels in deep water were lower than anticipated based on modeling, while received levels in shallow water were higher.

While the seismic airgun pulses are directed towards the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994). In waters 25-50 m deep, sound produced by airguns can be detected 50-75 km away, and these detection ranges can exceed 100 km in deeper water (Richardson et al., 1995a) and thousands of kilometers in the open ocean (Nieukirk et al., 2004).

Richardson et al. (1995a) 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 (Richardson et al., 1995a). In this activity, hydraulically driven pads mounted beneath a line of trucks are used to vibrate, and thereby energize the ice. Noise incidental to the activity is introduced by the vehicles associated with this activity.

Noise from Other Exploration, Development, and Production Activities. Offshore exploration and production drilling platforms (free-standing or drillships) use machinery and equipment that emit noise into the marine environment. While most of this noise is relatively localized, organisms can be attracted to or be displaced away from these sites.

Onshore oil-production facilities (and associated buildings, pipelines, roads, etc.) have equipment (machinery and vehicles) or people that generate noise. There currently are no oil-production facilities in the Chukchi Sea. There is one operating oil-production facility on an artificial island and several others in planning and construction stages in the Beaufort Sea. There are two other developments on causeways. While sounds originating from drilling activities on islands can reach the marine environment, Richardson et al. (1995a) reported that noise typically propagates poorly from artificial islands, as it must pass through gravel into the water. Richardson et al. (1995a) reported that during unusually quiet periods, drilling noise from ice-bound islands would be audible at a range of about 10 km, when the usual audible range would be ~2 km. Richardson et al. (1995a) also reported that broadband noise decayed to ambient levels within ~1.5 km, and low-frequency tones were measurable to ~9.5 km under low ambient-noise conditions, but were essentially undetectable beyond ~1.5 km with high ambient noise. Much of the production noise from oil and gas operations on gravel islands is substantially attenuated within 4 km and often not detectable beyond 9.3 km away.

Richardson (2006) summarized results from acoustic monitoring of the offshore Northstar production facility from 1999-2004. Northstar is located on an artificial gravel island in the central Alaskan Beaufort Sea. In the open-water season, in-air broadband measurements reached background levels at 1-4 km and were not affected by vessel presence. However, Blackwell, Greene, and Richardson (2004) pointed out that "…an 81 Hz tone, believed to originate at Northstar, was still detectable 37 km from the island." However, based on later measurements, that tone was not repeated in future years. Based on sound measurements of noise from Northstar obtained during March 2001 and February-March 2002 (during the ice-covered season), Blackwell et al. (2004) found that background levels were reached underwater at 9.4 km when drilling was occurring and at 3-4 km when it was not. Irrespective of drilling, in-air background levels were reached at 5-10 km from Northstar. In the absence of vessel noise, averaged underwater broadband sounds generally reached background levels 2-4 km from Northstar. Underwater noise levels from a hovercraft, which BPXA began using in 2003, were quieter than similarly sized conventional vessels. The hovercraft has replaced much of the helicopter traffic to the Northstar facility.

3.2.7.2.3. Miscellaneous Sources. Acoustical systems are associated with some research, military, commercial, or other vessel use of the Beaufort or Chukchi seas. Such systems include multi-beam sonar, sub-bottom profilers, and acoustic Doppler current profilers. Active sonar is used for the detection of objects underwater. These range from depth-finding sonar, found on most ships and boats, to powerful and sophisticated units used by the military. Sonar emits transient, and often intense, sounds that vary widely in intensity and frequency. Although not commonly used in the Arctic, acoustic pingers used for locating and positioning oceanographic and geophysical equipment also generate noise at frequencies greater than about 10-20 kHz. LGL, Ltd. (2005) describes many examples of acoustic navigational equipment.

3.3. BIOLOGICAL ENVIRONMENT.

3.3.1. Threatened and Endangered Birds

3.3.1.1. Spectacled Eider *(Somateria fischeri).*

3.3.1.1.1. General Life History. 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 (ACPs) 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.

Spectacled eider density varies across the Alaskan ACP (Larned, Stehn, and Platte, 2006). Aerial surveys targeting eiders have been conducted annually by the USDOI, Fish and Wildlife Service (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. About 12,000 non-breeding birds off the North Slope breeding grounds are presumed to remain at sea. 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, and males originally from one breeding ground depart with a female to her breeding ground. Female spectacled eiders return to their previous nest location for renesting.

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 3.2.4, 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. 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, however, 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). Sonsthagen et al. (2006) reported that common eider females have high fidelity to natal and breeding areas, in part, due to restricted female dispersal between island groups. Female eiders also 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. It remains unproven that spectacled eiders share this same degree of nest-site fidelity and kinship relationship, or whether these attributes are unique to island-nesting common eiders.

Male spectacled eiders leave the nesting area at the onset of incubation 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) (Figure 3.3.4.2-1). 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 a low 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).

Based on telemetry data for molt migration in the Chukchi Sea, male spectacled eiders migrated 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.

3.3.1.1.2. Endangered Species Act Status of the Spectacled Eider. 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, 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, hunting, predation, lead poisoning and ecosystem change.

Habitat Loss. At least 13,400 km^2 (5,172 mi^2) of Alaskan ACP may be spectacled eider-nesting habitat, <3,240 km^2 (1,250 mi^2) of which have been developed as oil-production fields (Section 3.1). No more than 168 km^2 (~65 mi^2 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. Some changes could benefit eiders and others may not and these changes are impossible to predict with any certainty.

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; USDOI, 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 predate on eiders or their young. Eiders historically nested in association with geese, possibly as a strategy to reduce predation losses. 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 and other community development activities could provide additional denning sites, which could allow foxes to expand their range/density and increase predation on nesting spectacled 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, USDOI, 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 spectacled 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) spectacled 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 spectacled eiders on the Y-K Delta. Exposure to lead shot similarly may affect spectacled eiders in some areas of the ACP.

Ecosystem Change. Marine spectacled eider habitat in the U.S. 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 spectacled eiders are evident (Derome et al., 2004). For example, research indicates that the size of clams available to the worlds' population of wintering spectacled 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 spectacled eiders (Lovvorn et al., 2008; Grebmeier 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).

3.3.1.2. Steller's Eider *(Polysticta stelleri).*

3.3.1.2.1. General Life History. The Alaska breeding population of Steller's eiders was listed as a threatened species under the ESA in June 1997. 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). 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 were 0.04 Steller's eiders/km^2. 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 birds/km^2 (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 per nest 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. commun.) 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.

3.3.1.2.2. 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. 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 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.

Steller's eider habitats or important habitat components (e.g., prey base, ice distribution, etc.) may be physically modified by climate change. Some changes could benefit eiders and others may not and these changes are impossible to predict with any certainty. 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.

3.3.1.3. Kittlitz's Murrelet *(Brachyramphus brevirostris)*.

3.3.1.3.1. General Life History. This species may nest as far north as Cape Beaufort (100 km northeast of Cape Lisburne) in the Amatusuk Hills (Figure 3.3.4.2-2). 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 proposed lease-sale areas. 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 are likely to 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).

3.3.1.3.2. ESA Status of the Kittlitz's Murrelet. This bird is listed as a candidate species (Listing Priority Number 2) throughout Alaska under the ESA. 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." Listing as a candidate species does not guarantee that the species will be listed as threatened or endangered during a particular time period, if its status is ever elevated at all.

3.3.1.4. Yellow-Billed Loon (*Gavia adamsii*).

3.3.1.4.1. General Life History. The yellow-billed loon is the largest of the three loon species associated with the Alaskan Arctic Coastal Plain. Yellow-billed loons typically nest on low islands or narrow peninsulas on the edges of large, deep, tundra lakes (Johnson and Herter, 1989). The loon is strongly defensive of breeding territories, driving off conspecifics, other loons and even other ducks (North 1994). The adults remain in the nesting lake until the chicks fledge so the nesting territory must provide a sufficient prey-base (primarily fish) to support the adults and young chicks. North (1994) suggested that the yellow-billed loon population is probably limited by a lack of suitable nesting habitat and that there is a large surplus nonbreeding population. Losses from drowning in subsistence fishing nets along the Chukchi and Beaufort sea coasts and other fishing activities in Asia may be the largest form of human-related mortality. Human disturbance during breeding can also affect reproductive success of nesting pairs.

Johnson, Wiggins, and Wainwright (1992) reported densities of fewer than 0.01birds/km^2 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, habitats. 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.

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 nonsignificant, 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. 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 long-term loss of permafrost could result in the widespread decline of wetlands on the ACP, including tundra lakes used by nesting yellow-billed loons.

The yellow-billed loon is relatively rare in arctic tundra regions (North 1994). 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 nonbreeders. Additionally, there are approximately 1,500 yellow-billed loons, presumably juvenile nonbreeders 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 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 (Rizollo and Schmutz 2008).

3.3.1.4.2. ESA Status of the Yellow-billed Loon. This bird is listed as a candidate species (Listing Priority Number 8) throughout its range under the ESA (74 *FR* 12931, 2009). The FWS defines a candidate species as one for which they have sufficient information to prepare a proposed rule to list because the species is in danger of extinction or likely to become endangered within the foreseeable future throughout all or a significant portion of its range, but the development of a listing regulation is precluded by other higher priority listing activities (including the Kittlitz's murrelet). Listing as a candidate species does not guarantee that the species will be listed as threatened or endangered during a particular time period, if its status is ever elevated at all. In the past 5 years, a status assessment and Conservation Agreement were developed (Earnst, 2004; 71 *FR* 13155), but may be due for updating.

3.3.2. Polar Bear.

3.3.2.1. General Life History of the Polar Bear. Polar bears are the apical (top) predators of the Arctic marine ecosystem (Amstrup, 2003) and are specialized predators of phocid (ice) seals in ice-covered waters (Derocher, Lunn, and Stirling, 2004). Polar bears have a circumpolar distribution in the Northern Hemisphere, and the global population was last estimated at 21,500-25,000 (Lunn, Schliebe, and Born, 2002). The polar bears' preferred habitat is the annual ice over the continental shelf and inter-island archipelagos that encircle the polar basin (Derocher, Lunn, and Stirling, 2004). There are two polar bear stocks recognized in Alaska: the southern Beaufort Sea stock (SBS) and the Chukchi/Bering seas stock (CBS). There is considerable overlap between the two stocks in the western Beaufort/eastern Chukchi seas (Amstrup et al., 2005). The SBS population ranges from the Baillie Islands, Canada, westward to Point Hope, Alaska, and is subject to harvest from both countries. On an annual basis, more than 90% of the bears in the SBS subpopulation occur between the Colville River in Alaska and the Mackenzie River in Canada (Cronin, Amstrup, and Scribner, 2006). Similarly, more than 90% of the bears in the CBS subpopulation occur west of Cape Lisburne (Cronin, Amstrup, and Scribner, 2006). The CBS stock ranges from Point Barrow, Alaska, west to the Eastern Siberian Sea. These two populations overlap between Point Hope and Point Barrow, Alaska, centered near Point Lay (Amstrup, 1995).

In 2002, the IUCN/SSG PBSG estimated the size of the CBS population at 2,000+ bears, although the certainty of this estimate was considered poor (Lunn, Schliebe, and Born, 2002). In 2006, the SBS population estimate was 1,526 individuals (Regehr, Amstrup, and Stirling, 2006).

3.3.2.2. Reproduction. Polar bears are a classic *K*-selected species, meaning they have delayed maturation, small litter sizes, 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 that there must be a high rate of survival to maintain population levels (Amstrup, 2003). Adult survivorship is correlated to sea-ice conditions in the SBS population (Regehr et al, 2007). In high ice years, adult survivorship can be 90%; however, in low ice years, adult survivorship drops 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., 2007).

Mating occurs from March to May, but implantation of the fertilized egg is delayed until autumn (Ramsay and Stirling, 1988). In any given year, 30-60% of the available adult females 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 two 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 five years of age (Lentfer and Hensel, 1980), giving birth for the first time at age six. The maximum reproductive age for polar bears is likely well into their 20s (Amstrup, 2003). The average reproductive interval for a 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 until autumn; hence, a malnourished female unable to sustain a pregnancy can terminate the process by aborting or resorbing the fetus (Amstrup, 2003).

Recent information on 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). In recent years, an unprecedented number of adult female polar bears have been found that had starved to death, and adult male body weights have declined. Survival rates of cubs of the year are now significantly lower than they were in previous studies, and there also has been a declining trend in cub of year size. Although many cubs are being born into the SBS region, more females apparently are losing their cubs shortly after den emergence, and these cubs are not being recruited into the population (Regehr, Amstrup, and Stirling, 2006).

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 near river banks or bluffs along the coastline, on barrier islands, on stable parts of the offshore pack ice, or on landfast ice (Amstrup and Garner, 1994). Studies have shown that more bears are now denning nearshore rather than in far offshore regions. Recent 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. This trend is thought to be related to climate change and changing sea-ice conditions (Fischbach, 2007). The highest density of terrestrial dens in Alaska occurs along the coastal barrier islands of the eastern Beaufort Sea and within the Arctic National Wildlife Refuge (ANWR) (Amstrup and Garner, 1994; USGS, unpublished data, 2007).

Although most polar bear denning in the Chukchi Sea occurs along the Russian coastline or on the pack ice, 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. In the Alaskan Chukchi Sea area, polar bear denning occurs at Cape Lisburne; Cape Beaufort; the barrier islands between Point Lay and Peard Bay; the Kukpowruk, Kuk, and Sinaruruk rivers; Nokotlek Point; Point Belcher; Skull Cliff; and Wainwright Inlet.

Newborn polar bear cubs are among the most undeveloped of placental mammals; therefore, undisturbed maternal dens are critical in protecting them from the rigors of the arctic winter for the first two months of life (Amstrup, 2000). Denning females are particularly sensitive to disturbance, and any cubs driven from their dens during the first few months of life will die. Significant changes in cub survival and physical stature ultimately has population-level effects (Regehr, Amstrup, and Stirling, 2006). For example, in other regions, declines in cub survival and physical stature were documented before statistically significant declines in population size were confirmed (Stirling, Lunn, and Iacozza, 1999).

3.3.2.3. Foraging, Habitat and Distribution. 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 provide important feeding habitat for polar bears. 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 almost completely carnivorous, although they will feed opportunistically on a variety of foods including carrion, bird eggs, and vegetation (Smith, 1985; Smith and Hill, 1996; Derocher, Wiig, and Bangjord, 2000). Polar bears prefer shallow-water areas, perhaps reflecting similar preferences by their primary prey—ringed seals—as well as the higher productivity in these areas (Durner et al., 2004). In spring, polar bears in the Beaufort Sea overwhelmingly prefer regions with ice concentrations >90% and composed of icefloes 2-10 km in diameter (Durner et al., 2004). In summer, bears in the Beaufort Sea select habitats with a high proportion of old ice, which carries them far from the coast as the ice melts. Approximately 75% of bear locations in the summer occur on sea ice over waters >350 m deep. 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), thus placing them well out of reach of polar bears summering on the 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 in the Beaufort Sea 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 is most abundant and accessible (Durner et al., 2004). Consequently, changes in the extent and type of this ice cover are expected to affect the distributions and foraging success of polar bears (Tynan and DeMaster, 1997).

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 the shallower waters of the continental shelf, The increased biological productivity around polynyas likely is the key factor in their ecological significance. Polynyas vary in size and shape, but tend to recur in the same areas yearly due to a combination of bathymetry and the effects of wind, tidal fluctuations, currents, upwelling, or a combination of these factors (Stirling, 1997).

Reductions in summer ice cover may affect polar bears in other ways. For example, summer sea-ice reductions affect 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 are able to grow in height. Whaling crews and other local hunters have reported increases in storm events in recent years (Galginaitis and Funk, 2004:24; Galginaitis and Funk, 2005:18). 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 2002, 2005, and again in 2007, and extreme minima in 2003 and 2004 (Stroeve et al., 2005; NASA, 2005). 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). A late-summer storm in the Beaufort in September 2000 developed waves 6-7 m high at Point Barrow (Lynch et al., 2003). The increase in open water combined with such large waves undoubtedly would induce energetic stress and could lead to drowning in any swimming bears unfortunate enough to be caught in them (Monnett and Gleason, 2006). The increase in severe storm events is also increasing erosion along the coasts of the Chukchi and Beaufort seas, which may change the availability of denning habitat along coastlines and barrier islands.

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 that apparently swam for more than 557 km (221 mi) from Norton Sound back to the retreating pack ice in the Chukchi Sea northwest of Wainwright (Amstrup et al., 2006). 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 four dead adult polar bears that may have drowned following a severe storm event in the Beaufort Sea in fall 2004, and attributed this phenomenon to longer open-water periods and reduced sea-ice cover, which may force bears to either fast for longer periods or swim longer distances to reach food sources on shore. If such events are recurrent, they could have a moderate 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). 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 along the Alaskan coastline 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 ANWR (Schliebe et al., 2005). Congregations of more than 60 polar bears and as many as 12 brown 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). 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; Ovsyanikov, 2003; Schliebe et al., 2005; Kochnev, In prep.).

When environmental factors result in minimal ice conditions, it may affect polar bear hunting success. In these situations, walrus haulouts become important foraging areas for bears 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, In prep.). According to Nikita Ovsyanikov, 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 (Ovsyanikov, 2003).

Due to ice patterns and prevailing winds, many walrus and a relatively large number of polar bears can come ashore on the north coast of Chukotka during late summer and autumn. When disturbance events occur, many walrus can die in stampedes, which may provide scavenging opportunities for stranded bears (Ovsyanikov, 2003) and bring the bears into close proximity to Native villages. The fact that more bears are visiting the northern coast of Chukotka does not reflect an increase in the number of polar bears, but rather the growing impact on bears from the reduced sea-ice cover in the summer and autumn (Ovsyanikov, 2003).

Each year, seven or more beach-cast whales wash up along the Chukotka coast (Kochnev, in prep.). 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). Aggregations of polar bears feeding on beached carcasses have occurred repeatedly (Kochnev, In prep.). 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, In prep.). In recent years, as many as 50 bears congregated on Kolyuchin Island between August and November (Kochnev et al., 2003; Kochnev, In prep.), and from 7-20 bears concentrated in five other areas along the north coast of Chukotka (Kochnev, In prep.). In Chukotka, bears appear in great numbers along the coast near the Native village of Vankarem in October and November. As many as ten bears a day may come into the village while moving along the coast. The bears are attracted to the village by the smell of Native-harvested walrus meat (Kochnev et al., 2003).

Over the last 15 years, when the ice edge retreated far to the north of Wrangel Island, walrus formed large haulouts on Somnitel'naya Spit and Cape Blossom on Wrangel Island. When disturbance events cause the walrus to panic, they stampede into the water, often running over and injuring one another in the process. Between 24 and 104 walrus/year are killed during walrus stampedes on Wrangel Island. Additional walrus are killed by polar bear predation. The walrus carcasses, in turn, attract coastal aggregations of bears that usually peak in the second half of October (Kochnev, In prep.). Bears appear near walrus rookeries on Wrangel Island in early August, which is about a month prior to when walrus arrive (Kochnev, 2002). The maximum number of bears coming ashore on Wrangel Island most frequently occurs in late October, with an average of 50 bears and a maximum of 140 bears (Kochnev, 2002). Bear densities can approach 69 bears/km^2. The walrus carcasses available on Wrangel Island as a food source for polar bears average 27 tons per season. This is the most important resource for bears on the island in autumn and early winter (Kochnev, 2002). The correlation between bear numbers and increased distance to the pack ice during autumn indicates that the magnitude of bear concentrations on land depends on the Chukchi and East Siberian sea-ice condition (Kochnev, In prep.). The position of Wrangel Island, an isolated land mass at a high latitude in the Chukchi Sea, contributes to observed use patterns by walruses and polar bears (Kochnev, In prep.).

From 10-13 walrus-haulout sites occur annually in summer and autumn on the Arctic coast of Chukotka. In addition, not less than seven to eight beach-cast whales occur annually (Kochnev, In prep.). From 1999 through 2004, bears continued forming large aggregations on the coast of Wrangel Island, although walrus numbers and mortality rates at haulout sites decreased (Kochnev, In prep.). On the U.S. side of the Chukchi, walrus haulout sites have been rare (Kochnev, In prep.). In recent years, however, large haulouts have formed near Cape Lisburne, as walrus have been forced ashore when the sea ice retreats north of the continental shelf (Garlich Miller, 2007, pers. commun.).

3.3.2.4. Hunting

Sport hunting of polar bears has been banned in Alaska since 1972, although bears are still taken for traditional uses 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 near sustainable levels, although recent population estimates by Regehr, Amstrup, and Stirling (2006) call that assumption into question. 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, unpublished data). For the same period, 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, 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 distribution due to environmental conditions, decreased hunter effort, or a combination of these factors (USDOI, FWS, 2003).

Russia prohibited polar bear hunting in 1956 in response to 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. It is likely that this rate of harvest was unsustainable and 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. With the collapse of the USSR in 1991, levels of illegal harvest increased sharply in Chukotka in the Russian Far East (Amstrup, 2000; USDOI, FWS, 2003). The magnitude of the Russian harvest from the CBS is not precisely known. Although the figure is likely between 100 and 250 bears per year, some estimates place it as high as 400 bears per year. 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 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. However, because of the unknown rate of illegal take, the IUCN/SSG Polar Bear Specialist Group has designated the status of the CBS stock as "declining" from its previous estimate of 2,000+ animals (IUCN/SSG PBSG, 2006).

As a result of polar bears spending more time at walrus haulouts near villages in Chukotka, the illegal harvest of polar bears on the Chukotka coast was higher in 2002 than during previous years, with approximately twice the usual illegal take. Experts estimate that the illegal polar bear take in Chukotka in 2002 was between 250 and 300 animals (Ovsyanikov, 2003). The recent illegal polar bear take in Chukotka appears to be for commercial use (Ovsyanikov, 2003). This level of mortality is unsustainable, and highlights the peril of the CBS polar bear stock.

3.3.2.5 Climate Change Trends. The status of polar bears worldwide is declining primarily as a result of climate change and the resultant loss of sea-ice habitat (73 *FR* 28212-28303). The recent release of the Arctic Climate Impact Assessment's report on *Impacts of a Warming Arctic* (ACIA, 2004), combined with a peer-reviewed analysis of the effects of climate change on polar bears by three of the world's foremost polar bear experts (Derocher, Lunn, and Stirling, 2004), indicate that polar bears are facing a cascading array of effects as a result of dramatic changes to their habitat. Observed changes to date include reduced sea-ice extent, particularly in summer, and progressively earlier sea-ice breakup dates, especially in more southerly areas. Bears at the southern edge of the species' range already are showing the impacts of these changes

Recent research has indicated that the total sea-ice extent has declined over the last few decades, particularly in nearshore areas and in the amount of multiyear ice in the polar basin (Parkinson and Cavalieri, 2002; Comiso, 2002a,b). 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 would have negative effects on their populations (USDOI, FWS, 1995). Climate change already has affected polar bears in the Western Hudson Bay (WHB) population in 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 the WHB population of polar bears with a trend toward earlier breakup of sea ice in recent years. 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 also could 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). In fact, a new 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.

Climate change also may explain why coastal communities in WHB recently have experienced increased bear-human conflicts prior to freezeup 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. As they exhaust their fat reserves towards the end of the ice-free period, they are more likely to encroach on human settlements in search of alternative food sources and come into conflict with humans. The increase in polar bear-human interactions in WHB probably reflects an increase in nutritionally stressed bears searching for food (Amstrup et al., 2006). Similar effects may be occuring in Alaska. Polar bear use of coastal areas during the fall open-water period has increased in recent years in the Beaufort Sea. This change in distribution has been correlated with the distance to the pack ice at that time of year (i.e., the farther from shore the leading edge of the pack ice is, the more bears are observed onshore) (Schliebe et al., 2005).

Climate change also has affected the severity of autumn storm events as a result of reduced sea-ice cover. In 2001, rough weather prevented scouting about one-third of the time that whaling crews were on Cross Island (Galginaitis and Funk, 2004:24) and about half of the time during 2003 (Galginaitis and Funk, 2005:18). The unusually rough water that restricted the scouting for whales might have been related to changes in the summer ice cover during recent years. An analysis of long-term data sets indicates that substantial reductions in both the extent and thickness of the arctic sea-ice cover have occurred during the past 20-40 years, with record minimum extent in 2002 and again in 2005, and extreme minima in 2003 and 2004 (Stroeve et al., 2005; NASA, 2005).

The increased temporal and spatial extent of late summer and early autumn open water in northern Alaska has led to the dramatic erosion of coastal shorelines and bluff habitats, which often are preferred den sites for maternal polar bears (Durner, Amstrup, and Ambrosius, 2006). When the ice cover is reduced, particularly during late summer, the available open-water surface area increases and waves are able to grow in height. Typical wave heights are up to 1.5 m during summer and up to 2.5 m during fall. Expected maximum wave heights are 7-7.5 m in the Beaufort Sea (Brower et al., 1988); 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 undoubtedly would induce energetic stress, or worse, in any swimming bears unfortunate enough to be caught in them. Despite being strong swimmers, energetically stressed bears are susceptible to misfortune on long-distance swims. For example, Monnett and Gleason (2006) reported unprecedented polar bear mortalities following a severe storm event in the Beaufort Sea in fall 2004 and attributed the phenomenon to longer open-water periods and reduced sea-ice cover.

Polar bear terrestrial denning likely will become more important in the near future. The SBS polar bear population is unique in that approximately 50% of its maternal dens occur annually on the pack ice (Amstrup and Garner, 1994). A high level of sea-ice stability is required for successful denning. Reproductive failure is known to occur in polar bears that den on unstable ice (Lentfer, 1975; Amstrup and Garner, 1994). If global climate change continues to decrease sea ice in the Arctic and increase the amount of unstable ice, a greater proportion of polar bears may seek to den on land (Durner, Amstrup, and Ambrosius, 2006). Those that do not may experience increased reproductive failure, which would have population-level effects. Considering that 65% of confirmed terrestrial dens found in Alaska from 1981-2005 were on coastal or island bluffs, the loss of such habitats, through storm-surge erosion, likely would alter future denning distributions (Durner, Amstrup, and Ambrosius, 2006) which, in turn, could affect reproductive success. In the SBS population, cub of year survival has decreased dramatically; recruitment is still high, but not as many cubs are surviving into the next year of their life (Regehr et al., 2007).

Polar bears also are susceptible to mortality from den collapse resulting from warmer temperatures and unusual rain events during late winter (Clarkson and Irish, 1991). In Alaska and western Canada, winter temperatures have increased by as much as 3-4 °C (5.4-7.2 °F) over the last 50 years, and rain events have increased substantially across much of the Arctic (ACIA, 2004).

In contrast to other species that may be able to shift northwards as the climate warms, polar bears are constrained to productive sea-ice habitat over relatively shallow waters. There is limited scope for a northward shift in distribution, as deep-water habitats likely would provide an unsuitable prey base for these large carnivores (Derocher, Lunn, and Stirling, 2004). There also is limited scope for polar bears to move to terrestrial habitats. Although polar bears are known occasionally to feed on vegetation, berries, kelp, caribou, muskoxen, ptarmigan, sea birds, crabs, and even ground squirrels, they remain the apical predators of the arctic marine ecosystem (Amstrup, 2003), specialized in preying on phocid seals in ice-covered waters (Derocher, Lunn, and Stirling, 2004). Polar bears are very susceptible to overheating and are very inefficient walkers and runners, expending about twice the average energy of other mammals when walking (Best, 1982). This inefficency helps explain why polar bears are not known to prey regularly on muskoxen, caribou, and other land animals, as the energy required to catch such animals almost certainly would exceed the amount of energy a kill would provide. For these reasons, polar bears are unlikely to be able to compensate for reduced ringed seal availability by switching to terrestrial food sources (Derocher, Lunn, and Stirling, 2004).

Projected impacts to polar bears from climate change would affect every aspect of the species' existence. The timing of ice formation and breakup will determine how long and how efficiently polar bears can hunt seals. Reductions in sea ice will result in increased distances between the ice edge and land which, in turn, will lead to increasing numbers of bears coming ashore during the open-water period, or drowning in the attempt. Reductions in sea ice also will increase the polar bears' energetic costs of traveling, as moving through fragmented sea ice and open water is more energy intensive than walking across consolidated sea ice. Reductions in sea ice may result in reduced availability of ringed seals, and would result in direct mortalities of bears from starvation. Continued climate change also likely would increase the occurrence of bear-human interactions on land. All of these factors are likely to result in impacts to polar bear populations and distribution similar to what has already been documented in more southerly areas, such as Western Hudson Bay.

3.3.2.6. ESA Status of the Polar Bear

On May 15, 2008, the FWS published a Final Rule that listed the polar bear as threatened throughout its range under the ESA (73 *FR* 28212). The status of polar bears worldwide is declining, primarily due to climate changes and the resulting loss of sea-ice habitat. 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).

The listing process began on February 16, 2005, when the Center for Biological Diversity (CBD) petitioned the FWS to list the polar bear as a threatened species under the ESA (CBD, 2005). 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). On February 7, 2006, the 90-day finding by the FWS determined that the CBD petition contained sufficient information to indicate that listing polar bears as threatened may be warranted (71 *FR* 6745). The FWS conducted a 12-month status review of the species and concluded that listing the polar bear as a threatened species was warranted. On January 9, 2007, the FWS proposed to list the polar bear as a threatened species under the ESA (72 *FR* 1064). 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).

4. ENVIRONMENTAL CONSEQUENCES

In this section, we determine the anticipated effect of the Proposed Action on threatened and endangered birds and the polar bear. Our Proposed Action is to continue to authorize oil and gas exploration and development activities on the Alaskan Arctic OCS consistent with our previous leasing programs (Figure B) and those specified in our current 5-Year program. At this time industry holds leases on fewer than 500 lease blocks from a number of previous lease sales in the Chukchi Sea and fewer than 250 lease blocks from a number of 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). Our current program proposes additional lease sales in the Beaufort Sea and Chukchi Sea Planning Areas. Sales 209 and 217 in the Beaufort Sea would offer for lease the entire program area as scheduled in the 2007-2012 5-Year Program (Figure A). The Beaufort Sea program area encompasses approximately 6,123 whole or partial blocks that cover approximately 33,194,467 acres (about 13,426,469 hectares). Sales 212 and 221 in the Chukchi Sea would offer for lease the entire area as scheduled in the 2007-2012 5-Year Program (see Figure 2-2 in the DEIS). The Chukchi Sea program area encompasses 7,326 whole or partial blocks that cover approximately 40,192,866 acres (about 16.1 million hectares). These areas, minus any blocks currently leased at the time of the sale, would be offered in the proposed sales.

4.1. Factors Considered for Effects Analyses.

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

Timing. The window of time for exploration typically includes the open-water period. This largely eliminates potential effects during spring migration for marine and coastal birds and to polar bears, unless exploration vessels traverse the spring lead system. Effects still are possible during open-water periods where activities could affect birds that are molting, foraging, and migrating after the breeding season. Currently, seismic activities are typically restricted in the spring lead systems until after July 1 through the LOA/IHA processes. Nearshore on-ice seismic operations occur in late winter/ early spring and have the potential to encounter polar bears or polar bear dens. For production, operations could take place year-round, and effects may be possible from a variety of sources throughout the year.

Residence Time and Periodicity. Effects vary based on whether activity in the area is short-term or long-term and whether it involves passage through an area on a frequent or intermittent basis. Seismic operations may operate for 20-30 days in a specific area. During exploration, drill ships could be at a particular location for about 90 days, depending on the site characteristics. Support vessels and aircraft likely would need to make trips between a drill ship and shore to deliver personnel and equipment. Residence time and periodicity of drill ships, seismic operations and support vessels during exploration could affect molting, foraging, and post-breeding migrant ESA-listed birds and could affect polar bear movements, depending on location and timing. Production facilities have a relatively small footprint, but may remain over several decades. These facilities have the potential to attract curious or hungry polar bears or to displace bears from denning or foraging in nearby areas.

Spatial Extent. The lease sale areas are large, and areas explored in any given season are small by comparison. Beyond the footprint of a seismic vessel, drill ship, or other facility, consideration must be given to the area affected by noise, support-vessel or aircraft traffic, hunting access, and other secondary factors that could affect birds and polar bears, such as ice roads, support camps or other associated infrastructure.

Environmental Factors. Weather, currents, wind, and other environmental variables all influence the intensity or magnitude of potential effects. Limited visibility due to fog, rain, and snow can affect the ability of birds to detect structures and avoid them. Limited visibility, coupled with bright lights, however, may attract birds and increase the risk of collisions.

Oil Spills. If a large oil spill occurred where there were concentrations of ESA-listed birds or polar bears, large-scale mortality could occur, representing a major population-level effect. Large spills could arise from a variety of sources, especially during bulk fuel deliveries or other marine accident. A very-large spill from a well blowout is described as a very unlikely event and evaluated in the DEIS, Appendix A, Section 1.1.4.

Extent of mortality that could result from oil spills during oil production is extremely difficult to estimate. First, it is uncertain that oil would ever be discovered. The potential that a commercial field would be discovered in the Chukchi Sea is ≤10% and about 20% in the Beaufort Sea. In actuality, based on exploration history, the likelihood that commercial quantities will be discovered is more likely an order of magnitude below these percentages (Appendix D of DEIS). Secondly, it also is uncertain that oil would be spilled. As stated in the Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003a), the chance of one or more large (≥1,000 bbl, 42,000 gal) spills occurring during the life of the project (~26 years) was 8-10%. The multiple-sale EIS and the Sale 195 EA explain that the occurrence estimate includes only part of the variability in the Arctic effects on the spill rate. During Fiscal Year 2004, MMS procured the study titled *Improvements in the Fault Tree Approach to Oil Spill Occurrence Estimators for the Beaufort and Chukchi Seas*. The study included the non-Arctic variability of spill frequency and spill size. An implication from this study is that the chance of one or more large spills increased from 8-10% (USDOI, MMS, 2003a: Section IV.A.4.a (1)) to 21% for Sale 202. The extent of mortality of marine and coastal birds from such a spill will be greatly influenced by the number, volume, trajectory, and timing as well as the period that oil remains in the environment.

Following production, a larger number of small spills (<1,000 bbl) could occur, but most of these would be into containment (not the open ocean), and their size limits spread and persistence due to weathering and other environmental factors. In addition, the low probability of such events, combined with the uncertainty of the location of the spill and the seasonal nature of the bird resources in the area, make it highly unlikely that numerous chronic small spills or a large oil spill would contact large numbers of marine and coastal birds or polar bears. Many marine and coastal birds are present on the North Slope for only 3-5 months out of the year. Even if birds were present in the vicinity of an oil spill, they might not be contacted by the oil due to avoidance behavior, ice conditions, or weather patterns. For example, 68,000 gal of heating oil were reportedly spilled into the Beaufort Sea near Kaktovik in 1988. No oiled birds, polar bears, or other wildlife were discovered and the USCG closed the case.

Considering the estimated mean number of spills and the low chance of one or more large spills occurring, coupled with a variety of other factors that would need to occur simultaneously to result in coastal and marine bird or polar bear mortality, we anticipate that it is highly unlikely that major impacts will result from oil spills associated with OCS oil and gas activities within the Chukchi Sea or Beaufort Sea lease-sale areas. The MMS 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. In addition, the FWS requires companies to provide OSRPs for review before they will issue an LOA. For the purposes of the following analyses, numerous small spills or large spills from OCS oil and gas activities are considered high effect, low likelihood events and are not considered reasonably foreseeable.

Scope of the Analysis. We determined the scope of the Proposed Action includes oil and gas development, other human activities, and environmental trends on the North Slope and adjacent offshore areas over the life of the Proposed Action. We weighed more heavily those activities that were more certain, closer in time, and closer geographically to the proposed lease-sale areas to keep the cumulative effects analysis concentrated on the effects in the action area. Activities further away in time or farther from the action area were considered more speculative and not reasonably foreseeable.

4.2. Reasonably Foreseeable and Speculative Future Events.

[note: Unless otherwise noted, all section, table, and map references in Section 4.2 refer to the DEIS]

In this section we consider activities or events that were considered likely to occur, regardless of leasing decisions made under the EIS. We assume other activities, such as subsistence hunting, fishing, and marine and air transportation will continue according to existing trends (Section 4.2.1.1). We identify anticipated oil and gas exploration, development and production activities, and projects in onshore and offshore areas of the Alaska North Slope (Sections 4.2.1.2); including those we considered to be speculative (Section 4.2.2). Other than recent press releases issued by the U.S. Coast Guard (USCG), we do not attempt to estimate future military activities affecting this region.

We assume the Trans-Alaska Pipeline System (TAPS) would continue to serve as the main transportation system for oil production from northern Alaska in the foreseeable future. Other North Slope facilities (processing plants, roads, and support services) also are in place to serve future production. This means that additional development will not necessarily require extensive new transportation infrastructure for the Beaufort Sea scenario.

In Section 4.2.1.4, we describe oil and gas exploration, development, production activities and projects we considered (1) reasonably foreseeable if they were likely to occur within 20 years, or (2) speculative if they would take longer to occur in Section 4.2.2. Other reasonably anticipated changes to the infrastructure, transportation, and existing environment on the North Slope and adjacent marine areas are described in Section 4.2.1.1.

4.2.1. Reasonably Foreseeable Activities and Events.

4.2.1.1. Transportation and Infrastructure. Coastal communities vary in size but typically have many of the same types of infrastructure. These structures and facilities include airstrips, landfills, and a variety of buildings and dwellings. The Bureau of Land Management (BLM) (USDOI, BLM, 2007) estimated that village facilities have directly impacted approximately 1,800 acres across the North Slope. We assume that the same trends associated with the maintenance and development of coastal communities will continue. One example of such activity is a proposed airport construction project at Barter Island. As a result of coastal flooding, the North Slope Borough (NSB), in conjunction with the Federal Aviation Administration, has proposed to relocate the existing airport at Barter Island. Activity associated with relocating this airport could impact up to 214 acres of wetlands as a result of the construction of gravel roads, lagoon, airport facilities, etc., depending on which alternative is selected (Hattenburg, Dilley, and Linnell, 2008).

As discussed in Chapter 3, individual oil pools and prospects have been developed as fields that share common wells, production pads, and pipelines. Over time, fields have been grouped into production units with common infrastructure, such as processing facilities. We assume that these same types of activities needed to support existing oil and gas infrastructure would continue into the future. The construction of gravel roads and pads, ice roads, and the excavation of gravel mines are examples of the types of activities associated with maintenance and development of oil and gas activity on the North Slope, and we assume these activities will continue to occur. However, the annual amount of surface disturbance associated with these activities likely would be at a slower rate than has been seen in the past two decades. Recent technologies have contributed to reduction in impacts associated with the development and production of oil and gas.

4.2.1.1.1. Aircraft Traffic. As discussed in Chapter 3, at least three airline companies provide passenger service to North Slope communities. ConocoPhillips and BP Exploration (Alaska), Inc. (BPXA) use a private jet company, Shared Services, Inc. At least four different companies move cargo between North Slope communities and Anchorage and Fairbanks in Alaska and Yellowknife in Canada. The majority of the intercommunity travel and freight hauling on the North Slope typically is with commuter-type aircraft operated by a number of smaller carriers. Government and university researchers sometimes charter aircraft for research projects. These activities are expected to continue. It is conceivable that aircraft activity directly associated with tourism and research could increase as a result of arctic climate change.

Industry uses helicopters to support routine activities such as seismic surveys, crew changes at offshore sites, and to resupply remote camps/facilities. Aircraft traffic associated with existing leases on and offshore would continue. Lease Sale 193 was held in February 2008. As a result of that sale, we expect aircraft traffic would increase by a minimum of one to three flights per day from Barrow. The increase in aircraft traffic resulting from exploration activity associated with Sale 193 potentially would occur during the summer months. Aircraft traffic associated with existing oil and gas activity onshore and in State waters also could contribute to increases in aircraft traffic. We assume that existing trends in aircraft traffic will continue in the absence of additional lease sales.

4.2.1.1.2. Vessel Traffic. As indicated in Chapter 3, current levels of vessel traffic in the proposed lease areas are relatively low but increasing. For example, traffic is relatively low in comparison with the Bering Strait and Unimak Pass, through which migrate large numbers of marine mammals. Traffic in the 85-kilometer (km; 52-mile [mi]) Bering Strait includes about 50 transits/year by ore carriers going to or coming from the Red Dog Mine. Traffic in the 45-km (28-mi) Unimak Pass includes many vessels on the Great Circle Route between Asia and North America; the traffic included an estimated 2,700 large vessels in 2004 and about 4,500 ships in 2007 (ADEC, 2005; NRC, 2008). In contrast, vessel traffic in the proposed Arctic lease area can be characterized as oil- and gas-related traffic plus smaller vessels used for hunting and between-village transportation during the open-water period.

Many essential items are transported to coastal villages and industrial sites via barge or small cargo vessel during the open-water period, including machinery, fuel, building materials, and other commodities. For example, the villages along the Chukchi coast are serviced each summer by a barge from Crowley Alaska, and the villages along the Beaufort coast are serviced by Crowley Alaska and/or Northern Transportation Co., Ltd. from the Northwest Territories, according to news articles (*Petroleum News*, 2002, 2003) and the company's web sites. We anticipate the trends associated with this type of vessel traffic will continue indefinitely into the future.

In addition to vessel traffic that supports coastal communities, vessel traffic exists in support of the North Slope oil and gas industry. For example, in 2006, Shell Offshore, Inc. proposed a 3-year exploratory program on their Federal leases (USDOI, MMS, 2007b). This program was stopped by court order in 2007 but could begin as soon as legal challenges are resolved. The Shell program could use tens of vessels to support this program, including spill-response vessels. An active seismic program also is proposed by BPXA in nearshore areas of the Beaufort Sea in 2008. The BPXA program proposes to use about 10 vessels, including a hovercraft during the open-water season in nearshore waters around the Endicott Causeway/Foggy Bay (USDOI, MMS, 2008b). Alaska Clean Seas (ACS) is a company that is contracted to respond quickly to spills on the North Slope and adjacent marine areas. This company periodically performs spill-response drills in marine areas to practice effective response strategies.

Numerous sources report recent increases in vessel traffic in the Arctic. We have only limited information on military vessels. For example, arctic research cruises by USCG icebreakers occur annually, and the USCG anticipates a continued increase in vessel traffic in the Arctic. According to the

USCG (2007), the primary source of their distress calls in the Arctic have been stranded whale hunters. The USCG is establishing a seasonal forward-operating base in Barrow, partly to decrease long-range rescue expenses (U.S. Coast Guard, 2007, 2008).

Vessel traffic overall is changing in the arctic seas as the open-water season begins earlier and ends later, and there is increased opportunity for shipping, research, and cruise-ship tourism. Shipping routes via the Northeast Passage are still much lower than they were before the Union of Soviet Socialist Republics recession but have increased recently as this route has opened on a more predictable basis. There are numerous recent articles describing the economic benefits of a shipping route through the Northwest Passage made possible by decreasing ice distribution, saving at least 4,000 mi from a route through the Panama Canal. The first Arctic shipping may be routed through the central Arctic because of the reduced seasonal ice concentration and thickness. A feasibility study of such trans-Arctic shipping was conducted for the Institute of the North (Niini, Arpiainen, and Kiili, 2006). The study examined the use of large icebreaking container ships on routes directly across the central Arctic year-round between the Bering Strait and Fram Strait. Research-vessel and cruise-ship traffic to the Arctic has increased, as people are observing areas that previously were inaccessible. For example, during 2007, the research icebreaker USCG *Healy* was in the Northern Chukchi Sea, and the Nome harbormaster records show that another three research vessels stopped in that port: the *Oscar Dyson*, a NOAA research vessel; the *Oshuru Maru*, a Japanese research vessel; and the *Sever*, a Russian research vessel. Some research vessels have sought projects/scientists for planned passages through the Northwest Passage during summer 2008 (i.e. M/V *White Holly* [http://www/whiteholly.org/Northwest%20Passage%20Expedition.html]). The Nome harbormaster records for 2007 show that three cruise ships stopped in that port; they might have cruised to marine mammal haulouts in the Chukchi Sea. The harbormaster records and web sites indicate that only one of the cruise ships plus three sailboats transited through both the Chukchi and Beaufort seas and Northwest Passage during 2007. For this analysis, we assume that existing trends associated with this type of vessel traffic will continue as arctic climate change occurs.

Changes in the distribution of sea ice and increasing interest in observing iconic wildlife and marine mammals appear to support an increase in adventure or luxury cruises in remote polar, especially Arctic, locations (http://www.alvoyages.com/arctic-cruises/). Some impacts from increasing cruise-ship traffic arise from these ships seeking opportunities for close-approach views of wildlife and marine mammals. We believe that an increase in this sort of vessel traffic is likely, regardless of oil and gas activity.

4.2.1.2. Pollution. In this section, we acknowledge the existence of sources of pollution that are not just associated with oil and gas activities but occur as a result of numerous activities and facilities already in place on the North Slope. Sources of pollution directly associated with the Proposed Action are covered in Section 4.3.2, Accidental Oil Spills. Some contaminants have no connection with oil and gas activities. A few examples of this sort of pollution can be runoff from coastal communities after precipitation or snowmelt, erosion of coastline into existing infrastructure, and sediment loading as a result of local construction projects near waterways. Sources of pollution that can be attributed to existing oil and gas activities are described in further detail below and can be assumed to continue as a result of existing oil and gas infrastructure. In the absence of additional lease sales, we recognize that oil- and gas-related sources of pollution, as well as nonoil- and gas-related sources of pollution will continue to exist into the future.

4.2.1.3. Climate Change. Chapter 3 described the physical resources that have been changing and are expected to continue changing over the reasonably foreseeable future. There are several changes expected for the Arctic, these include:

- More open water during the summer because winter sea ice forms later, is thinner, and melts sooner each year.

- A lack of sea ice allows offshore winds to create waves that subject the coastline to extensive erosion, storm surge, and saltwater intrusion into inland areas and lagoons.
- Wind, including more-frequent and severe storm events.
- Increased precipitation, particularly during the winter.
- Warmer temperatures resulting in earlier snowmelt.

4.2.1.4. Reasonably Foreseeable Oil and Gas Activities in the Alaskan Arctic (≤20 years).

4.2.1.4.1. Oil Exploration. For purposes of analysis, we assume that exploration activities will occur in the foreseeable future from recent State onshore and offshore leasing programs, onshore Federal leases in the National Petroleum Reserve-Alaska (NPR-A), and existing outer continental shelf (OCS) leases in the Beaufort and Chukchi seas. No large spills (greater than or equal to [≥]1,000) are assumed to occur from existing or reasonably foreseeable future offshore or onshore exploration activities.

Onshore Alaska North Slope. The State of Alaska develops and approves an oil and gas leasing program for a 5-year period, reassesses the plan, and publishes a schedule every other year. Between 2008 and 2012, the State is expected to hold the following annual areawide lease sales:

- onshore sales on the Arctic Slope, including unleased State lands between the Arctic National Wildlife Refuge (ANWR) and the NPR-A; and
- Foothills sale extending into the foothills of the Brooks Range.

We expect some Federal lease sales will be scheduled in the NPR-A in the future.

Beaufort and Chukchi Seas. For purposes of analysis, we assume the only exploration activities that will occur in the foreseeable future would result from recent State and Federal leasing programs. Offshore State leases exist in the Beaufort Sea, and offshore Federal leases exist in both the Chukchi and Beaufort seas (Sale 193 in the Chukchi; Sales 186, 195, and 202 in the Beaufort). The State is expected to hold annual area-wide lease sales in the Beaufort Sea extending from Barrow to the Canadian border.

Exploration activities are considered to be more predictable, because they occur closer to the present time and are a natural extension of the leasing process. That is, it is reasonable that companies who purchase leases will attempt to test these leases for commercial oil and gas accumulations. This will occur in a foreseeable timeframe, as leases are only valid for 10 years from the lease sale. However, only a small fraction of leases are ever tested by drilling (less than [<]5% in Alaska).

4.2.1.4.2. Oil Development and Production in the Beaufort and Chukchi Seas. We have defined reasonably foreseeable future development with respect to historical trends and timeframe. Table 3.1.1-1 lists the existing North Slope fields and discoveries that could be developed in the reasonably foreseeable future. Of all of the factors analyzed, the timing for future production is the most uncertain. For example, the Liberty prospect in the Beaufort Sea was first leased in 1979 and discovered in 1982 (then called the Tern Island prospect). Exploration drilling in 1997 reconfirmed it as a commercial-size pool (renamed the Liberty Project by BPXA). Various project proposals, studies, and permitting steps have taken place, and development work has just begun in 2008. This prospect lies only 7 mi offshore in 20 feet (ft) of water and <30 mi from the TAPS.

We have attempted to rank the chance for commercial development of these discoveries from highest to lowest (Table 3.1.1-1). The ranking in Table 3.1.1-1 also could be viewed as an approximate timetable for production startup. Discoveries near the top of the list are expected to begin production sooner and are more likely to be produced. Discoveries near the bottom of the list are expected to start production much later, and most of their oil production may occur more than 20 years into the future. Most likely, these activities would begin with development of discoveries close to existing field infrastructure. We have ranked the potential and timing of development according to resource size and proximity to existing infrastructure, given that resource volumes still are fairly uncertain in this category. Because there are inadequate data in the public domain, we do not attempt to define recoverable reserves on a field-specific basis, nor do we describe the designs of future facilities. As it is a company decision, we also cannot accurately define the timing for development. Many of these discoveries were made decades ago and remain undeveloped today.

Twenty-three discoveries are listed that might have development-related activities (site surveys, permitting, appraisal drilling, or construction) within the next 20 years, including several offshore fields in the Beaufort Sea (Liberty, Sandpiper, Kuvlum, Flaxman Island, Stinson, Nikaitchuq, Tuvaaq, and Hammerhead; see numbers 36 through 58 in Table 3.1.1-1). Some of the pools located offshore are developed from onshore sites and, therefore, are listed as onshore fields. Sandpiper, Liberty, Hammerhead, and Kuvlum are on offshore Federal leases; all others are on State leases or NSB lands. There are no confirmed discoveries in the Chukchi Sea that are anticipated to be developed within the next 20 years.

While the list of reasonably foreseeable future developments includes new field discoveries, there also could be significant amounts of oil recovered from existing fields and from satellite pools close to infrastructure areas. Without advancements in technology and sustained high oil prices, many of these discoveries could remain undeveloped in the future.

Onshore Alaska North Slope. For purposes of analysis, we assume that development activities will occur in the foreseeable future from existing, present, and reasonably foreseeable development on State and Federal lands. We estimate five small spills greater than (>) 500 barrels (bbl) and <1,000 bbl for onshore Alaska North Slope (Tables 4.2.1-1 and 4.2.1-2) and one large spill from TAPS (Tables 4.2.1-1 and 4.2.1-2).

Beaufort and Chukchi Seas. For purposes of analysis, we assume that some development activities in the Beaufort Sea could occur in the reasonably foreseeable future. Reserve estimates for Northstar, Oooguruk, Nikaitchuq, and the Duck Island Unit are included in our estimates for offshore developments as well as any confirmed discoveries in the Beaufort and Chukchi seas, such as Hammerhead and Kuvlum. We estimate the most likely number of large crude spills is zero in the offshore Beaufort or Chukchi seas (Tables 4.2.1-1 and 4.2.1-2).

4.2.1.4.3. Natural Gas Development and Production in the Beaufort and Chukchi Seas. A large-scale gas-transportation system from the North Slope will not be operational for at least a decade. Capacity in this system for new gas developments may not be available for another decade after that. When there is capacity in the system, future gas developments are likely to be prioritized according to accessibility and cost.

Beaufort Sea. Large volumes of natural gas have been identified as associated with oil fields on the North Slope. We assume that these natural gas resources would be produced for sale to outside markets. Natural gas has been cycled in North Slope oil fields for decades and would be readily available (produced through existing infrastructure) when a new North Slope gas-transportation project is completed.

There also is no accurate way to predict future gas-development activities outside of the core area of the North Slope, where most of the proven gas resources are located. The majority of future gas production during the first 10-15 years of gas-pipeline operation will be the gas that previously has been cycled through existing oil-production infrastructure. Thus, any environmental impacts of gas production in the period 2015-2030 largely would be an extension of current operations, where 8 billion cubic feet (Bcf) per day is now handled by existing facilities on the North Slope.

The largest gas accumulation on the North Slope is in the Prudhoe Bay field (approximately 23 trillion cubic feet (Tcf); see Table 3.1.1-4 for other stranded gas resources). These proven resources are uneconomic to produce, because there is no gas-transportation system to market. Various plans have been studied to bring North Slope gas to market but no plan has overcome the high project cost and marketing hurdles. At present, the most likely transportation system is a large-diameter gas pipeline to markets outside of Alaska. Upwards of 35 Tcf are in known accumulations on the North Slope, and these proven resources are likely to take all available capacity in the new gas pipeline for the first 10-15 years of its operation. We consider such a pipeline to be speculative at this time.

The main gas-transportation strategies are outlined below. These projects generally fall into two categories. It is uncertain which project (or combination of projects) eventually will be constructed.

- A large-diameter pipeline to markets in the U.S. Midwest. Overland pipeline routes would follow the TAPS corridor through Alaska and then through Canada.
- A pipeline across Alaska to tidewater (either Cook Inlet or Valdez), where gas would be converted to liquefied natural gas and shipped to various receiving terminals in the Pacific basin.

Through the years, each strategy has appeared to be more feasible at different times. At present, an overland pipeline system through Canada is the most popular. A discussion of the relative merits of these gas-transportation strategies is given in Sherwood and Craig (2001).

Chukchi Sea. Remote, high-cost gas projects in the Chukchi will be less attractive than projects lower in cost and closer to future infrastructure. Also, considerable gas resources will have to be discovered in the Chukchi to justify a large overland pipeline to the Prudhoe Bay area. All of these factors led us to conclude that gas development in the Chukchi OCS is speculative and should not be included in the reasonably foreseeable scenario.

4.2.2. Speculative Oil and Gas Activities in the Alaskan Arctic (>20 years).

As the project life exceeds a 20-year timeline, we include speculative exploration and development activities that could occur in onshore and offshore areas beyond 20 years from the present time, but we tend to give less weight to activities further away in time or farther from the lease-sale area. To represent the scale of future exploration and development activities in the speculative category, we summarize the resource assessments by various government agencies. Resources considered geologically potentially recoverable by current or foreseeable technology, without regard to economics, are listed in Table 3.1.1-1. It is reasonable to assume that the level of future activities will be proportional to the geologic potential in these areas, if they are open to leasing and exploration. High-potential areas could be expected to have higher levels of exploration and perhaps development.

4.2.2.1. Oil Exploration in the Beaufort and Chukchi Seas. We assume that only exploration activities would result from possible lease sales associated with future 5-year programs beyond 20 years. Exploration activities are a natural extension of the leasing process. That is, it is reasonable that companies who purchase leases will attempt to test these leases for commercial oil and gas accumulations as long as the leases are maintained. However, because the schedule of future lease sales in uncertain, any exploration after possible sales also is considered speculative in nature. Typically, only a small fraction of leases are ever tested by drilling (<5% in Alaska).

4.2.2.2. Oil Development and Production in the Beaufort and Chukchi Seas. The speculative category includes current sub-commercial discoveries in addition to undiscovered resources that could be leased as a result of future State and Federal lease sales in northern Alaska but developed beyond 20 years in the future. Some of the discoveries listed in Table 3.1.1-1 were made 50 years ago and remain undeveloped today. There are a variety of reasons, including very remote locations, low production rates, and lack of transportation systems, that will inhibit activities associated with these resources in the foreseeable future. With respect to undiscovered resources, it is impossible to accurately predict the timing of development, new infrastructure requirements, or the environmental effects associated with development projects that have not been located. These are speculative resources that may or may not ever be developed.

Sixteen discoveries are listed under the speculative category, because it is highly unlikely that they would be developed within the next 20 years (Table 3.1-1). Given the high petroleum-resource potential of northern Alaska, other discoveries are likely to be made as a result of exploration beyond the 20-year timeframe for the "foreseeable" future. It is reasonable to anticipate higher levels of activities onshore compared to offshore because of lower costs, easier logistics, and proximity to existing infrastructure. Undiscovered resources generally are described as speculative, because these pools have not been identified in size or location.

We recognize that companies may produce oil from pools now listed as speculative but the size, location, and start-up date for these fields is unknown today. Some of the discoveries listed were made as far back as 1946 but have not been developed for economic and technical reasons. It also is possible that companies will delay development of some prospects listed in the reasonably foreseeable category because of economic, technical, or regulatory hurdles.

4.2.2.3. Natural Gas Development and Production in the Beaufort and Chukchi Seas (resource estimates as they relate to spills). Because the existing North Slope oil infrastructure has the capability to handle large amounts of natural gas, it is not anticipated that a large increase in infrastructure, other than installation of the new gas pipeline itself, would be necessary to support a gas pipeline. Approximately 8 Bcf per day is handled by North Slope facilities, and the new gas pipeline is likely to carry 4.5-6.0 Bcf per day.

It is very unlikely that development of remote, undiscovered, and higher cost gas resources in the Chukchi or Beaufort seas would take priority over the development, production, and transport of more supplies of known available gas reserves. Because the key transportation system (probably a large diameter pipeline) may never be constructed, we assume any gas production from the offshore area or NPR-A is speculative.

4.3. Impact-Producing Factors.

4.3.1. Disturbances.

Disturbances are associated with certain activities such as vessel and aircraft traffic, community and industrial facility development, and oil and gas exploration, development, and production. In general, disturbance effects include sound (anthropogenic noises in air and underwater), the physical presence of vessels and aircraft, and other human activity displacing animals from important habitats. The displacement of animals from certain habitats could indirectly affect subsistence activities and success.

Disturbances to the environment occur during all times of the year. Aircraft activity occurs all year. Most vessel traffic and seismic surveys take place during the summer open-water season between June and November. Construction of community or industrial facilities tends to occur during summer, but gravel extraction and hauling can be done during winter using ice roads.

4.3.1.1. Sound. Noise, whether carried through the air, ice, or under water, may cause some species to alter their behavior, including changing feeding routines, movement, and reproductive cycles. Concerns about noise have been raised because of the potential direct effects on animals, particularly marine mammals and fish, as well as indirect effects on Alaskan Native subsistence activities.

The sources of sound in the Chukchi and Beaufort seas were described in Section 3.2.7. In the following section we describe the general characteristics of sound, particularly underwater sound. As we consider most anthropogenic sounds to be noise, this document focuses primarily on noise, particularly noise in the marine environment.

4.3.1.1.1. General Characteristics and Properties of Sound. 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 et al., 1995a).

The frequency of the sound usually is measured in Hertz (Hz), pressure level in microPascals (µPa) (Gausland, 1998), and intensity levels in decibels (dB) (Richardson et al., 1995a; McCauley et al., 2000). McCauley et al. (2000) and others (see references in McCauley et al., 2000) express this in terms of its equivalent energy dB re 1 μPa^2.

The perceived loudness of any given sound is influenced by many factors, including its frequency and pressure (Gausland, 1998), hearing characteristics of the listener, the level of background sound, and the physical environment through which the sound traveled before reaching the animal. Some generalities concerning sound include:

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

4.3.1.1.2. General Characteristics and Properties of Underwater Sound. Underwater sound essentially is the transmission of energy via compression and rarefaction of particles in the conducting medium (i.e., in this case, seawater). The pressure pulse from a sound source propagates outwards in an expanding spherical shell at approximately 1,500 meters per second (m/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 significantly 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.

Based on summaries in key references (e.g., Richardson et al, 1995a; Gausland, 1998; Ketten, 1998), and other references as noted, the following information about sound transmission is relevant to understanding the characteristics of sound in the marine environment:

- 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 (Richardson et al., 1995a; McCauley et al., 2000), and the characteristics (e.g., depth, orientation) of the receiver (Richardson et al., 1995a; Gausland, 1998).
- Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998).
- Extrapolation about the likely characteristics or impacts of a given type of sound source in a given location within the Chukchi and Beaufort seas based on published studies conducted elsewhere is somewhat speculative, because characteristics of the marine environment such as bathymetry, sound-source depth, and seabed properties greatly impact the propagation of sound

horizontally from the source (McCauley et al., 2000; see also Chapter 4 in Richardson et al., 1995a and references provided therein). Richardson et al. (1995a:425) summarized that: "…a site-specific model of sound propagation is needed to predict received sound levels in relation to distance from a noise source." Differences in site characteristics in different parts of the planning area make predictions about sound propagation relatively difficult.

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 μPa (dB re 1 μPa) (Madsen, 2005). Different reference units are appropriate for describing different types of acoustic stimuli.

4.3.1.2. Physical Presence.

4.3.1.2.1. Physical Presence of Vessels. Many animals seeing vessels react to them. The intensity and distance at which wildlife reacts is often related to previous experiences and the perceived vessel size, speed, and distance. As animals move through an area they can encounter or can otherwise be attracted to vessels, sometimes with deleterious consequences. Fatalities can occur if a fast-moving bird, for example, cannot see a vessel in time to avoid hitting it. In rarer situations, the animal cannot react in time or reacts in such a way that the vessel strikes and injures or kills it. For example, many alcids react to vessels by diving and can be struck when returning to the water surface.

4.3.1.2.2. Physical Presence of Aircraft. While many animals react to the sound of aircraft (planes or helicopters) and most often first become aware of an aircraft by hearing it, some can react to simply seeing an approaching aircraft. The intensity and distance at which wildlife reacts is often related to the size, speed, and distance of the aircraft. As an aircraft approaches an animal the aircraft increases in apparent size, and the animal reacts accordingly. Some aircraft resemble a threat posed by avian predators. Aircraft also can strike and injure or kill (mammals or birds) on runways or while flying (birds). Animal strikes are related to aircraft traffic and animal density.

4.3.1.2.3. Physical Presence of Development Facilities and Equipment. Facilities (buildings, pipelines, roads, etc.) have equipment (machinery and vehicles) or people that make noises. While most of these are relatively localized, animals can be attracted to or be displaced away from these sites. Birds are prone to striking some of these facilities during migration or inclement weather. As with aircraft, some animals can be struck by fast-moving vehicles. Some animals benefit from certain facilities for shelter (nesting or denning sites) or for scavenging food or nesting materials. Warier species often prefer to avoid such sources of activity.

4.3.1.3. Habitat Alterations. Habitat alteration can be viewed as a change or changes in the environment in which plants, animals, and humans exist. Habitat alteration can be caused by such activities as construction, new types of infrastructure, or alteration of water flow.

4.3.1.3.1. Emissions to the Air. Existing air quality of the Alaska Arctic is relatively pristine due to the remoteness, active ecological system, and the limited presence of human (anthropogenic) inputs. Industrial and community air emissions from power-generation, vessels; construction machinery; and other equipment, including compressors, generators, boilers, and various types of internal combustion engines, could affect air quality. Other effects on air quality would come from spilled oil, either due to evaporation or in situ burning of hydrocarbons, in the event of an oil spill. A more complete discussion on air quality is found in Section 3.2.6.

4.3.1.3.2. Discharges to the Marine Environment. Existing water quality of the Alaskan Arctic is relatively pristine due to the remoteness, active ecological system, and the limited presence of human (anthropogenic) inputs. Industrial and community impacts are minimal; with degradation of coastal water quality primarily confined almost exclusively to external intrusions, and naturally occurring processes. Existing pollution occurs at very low levels in arctic waters and/or sediments and do not appear to pose an ecological risk to marine organisms.

Any changes in marine water quality can cause problems, such as impeding or changing existing natural properties and processes, increased sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, and loss of fish and other aquatic populations.

Pollution to the marine environment comes from two primary sources: point sources and nonpoint sources.

4.3.1.3.2.1. Point-Source Pollution. The term point source is defined very broadly in the Clean Water Act (CWA) and has been through over 25 years of litigation. Point source has come to mean any discernible direct or specific discharge; as from a pipe, action, or operation. It also includes vessels or other floating craft from which pollutants are or may be discharged. The CWA prohibits anybody from discharging “pollutants” through a “point source” into a “water of the United States,” unless they have a National Pollution Discharge Elimination System (NPDES) permit. The permit contains limits on what can be discharged, monitoring and reporting requirements, and other provisions to ensure that the discharge does not hurt water quality or people’s health.

Existing or new leases in the Beaufort Sea could result in new discoveries and while considered to be speculative on an individual sale basis, our calculations that consider the past and proposed sales (five sales total) result in a 67% chance of development.

The general permit covers discharges from exploration in the Beaufort Sea and Chukchi Sea Planning Areas. The EPA Region 10 regulates industrial discharges of pollutants to surface waters in the Pacific Northwest and Alaska under the NPDES. Recent changes to EPA-administered NPDES regulations modify 122.26(a)(2) to expand the NPDES permit exemption to cover storm-water discharges of sediment from construction sites associated with oil- and gas-field operations, as mandated by the CWA amendment in the Energy Policy Act of 2005, together with CWA Section 402(l)(2). The new regulations also encourage voluntary application of best-management practices for oil- and gas-field activities and operations to minimize the discharge of pollutants in storm-water runoff and protect water quality. This would affect operators of oil- and gas-exploration, -production, -processing, or -treatment operations or transmission facilities and associated construction activities at oil and gas sites that are defined in 40 CFR 122.26(a)(2), (b)(14)(x), (b)(15), (c)(1)(iii) and (e)(8). An NPDES permit is required for those storm-water discharges from oil- and gas-field operations resulting in the discharge of reportable quantities of hazardous substances or oil that trigger notification requirements pursuant to 40 CFR 110.6, 117.21 or 302.6, or that contribute to a violation of water quality standards. Thus, storm-water discharges contaminated by contact with raw material, intermediate products, finished product, byproduct, or waste products, as indicated by discharges of reportable quantities of hazardous substances or oil, or by violations of water quality standards for pollutants other than sediment from a construction site associated with oil and gas operations, would continue to be subject to EPA NPDES regulatory and permitting requirements.

4.3.1.3.2.2. Nonpoint-Source Pollution. Nonpoint-source pollution resulting from oil- and gas-field activities and operations, unlike pollution discharges from industrial operations and plants, comes from many sources. Nonpoint-source pollution is caused by marine waters, rainfall, or snowmelt coming into contact with site buildings and facility components (deck/pad, machinery, material, pipelines, etc.). As the runoff moves across a facility, it picks up and carries away natural and human-made pollutants and deposits them into marine and coastal waters. These pollutants include:

- Oil, grease, and toxic chemicals from site/facility runoff and energy production;
- Sediment from exploration activities, construction and operational sites; and
- Bacteria and nutrients from wastes and faulty conditions.

Atmospheric deposition and hydro-modification also are identifiable sources of nonpoint source pollution, but they do not contain any significant portion attributed to the planning area oil and gas operations presently or in the foreseeable future.

Nonpoint-source discharges contaminated by contact with raw material, hazardous substances or oil, or by violations of water quality standards for pollutants other than sediment from a construction site associated with oil and gas operations, are subject to EPA NPDES regulatory and permitting requirements.

The presence of sediment in a discharge from construction or operation of oil- and/or gas-site activities is not itself indicative of significant negative impacts to the environment. Oil and hazardous substances for which there is a reportable quantity under either Federal regulations of the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) or the CWA are not likely to be found in normal and compliant exploration, development, and/or production operations; runoff or treatment operations; or transmission facilities.

“Management measures” are defined in section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) as economically achievable measures to control the addition of pollutants to coastal waters that reflect the greatest degree of pollutant reduction achievable through the application of the best-available nonpoint-pollution-control practices, technologies, processes, siting criteria, operating methods, or other alternatives. These management measures will be incorporated by owners/operators of OCS leases within any proposed post-lease activities. These management measures would be reviewed by the applicable State and Federal agencies, as well as states within their coastal nonpoint programs that, under CZARA, are to provide for the implementation of management measures.

Any proposed OCS oil and/or gas activity would entail an increase in present OCS operations. The degree and magnitude of impacts to water quality would depend on the activity, duration, degree of impact(s), and corresponding impact to receptors and stakeholders. Any proposed post-lease activities require MMS review and approval of plans/permits/application, and would include evaluation and environmental assessment of proposed activities and associated impacts, along with mitigations to ensure proper identification and compliance with required permits and regulatory requirements. An evaluation of potential impacts will be provided by MMS (30 CFR 250); NEPA review; and associated Federal, State, and local permits, plans, and applications approval for proposed post-lease activities. Cumulative impacts from these activities would adversely affect water quality; however, the impacts are expected to be local and temporary because of dilution, settling, and other natural altering and regenerative processes. These critical components of any post-lease action should mitigate adverse impacts to marine and coastal waters.

4.3.2. Accidental Oil Spills.

One of the impact pathways that stakeholders express concern about is an accidental oil spill into the environment from exploration, development, or production activities. The Exploration and Production (E&P) industry has a good record in reducing oil spills to the environment. The NRC (2003b) reports that accidental petroleum discharges from the E&P industry contributes 2% of the total annual release of petroleum into the sea for North America. Larger portions of the contribution come from the consumption of petroleum from land-based runoff, atmospheric deposition, recreational marine vessels, and jettisoned aircraft fuel. The largest contribution of oil in the sea is natural seeps.

This section addresses the assumptions about accidental oil spills, which will not necessarily occur under a Proposed Action, but have varying potential to occur. This section summarizes technical information from Appendix A. For details on any of these points, please read Appendix A of the DEIS. These assumptions form the basis for the effects analysis of oil spills on environmental, social, and economic resources in Sections 4.4 and 4.5 of the DEIS.

Predicting an oil spill is an exercise in probability. Uncertainty exists regarding the location, number, and size of oil spills and the wind, ice, and current conditions at the time of a spill. Although some of the uncertainty reflects incomplete or imperfect data, a considerable amount of uncertainty exists simply because it is difficult to predict events 15-40 years into the future. For analysis purposes, MMS estimates information about two general spill-size categories and two general phases of operations. Small and large spills are considered for development and production, and small spills are considered for exploration.

The oil-spill analysis considers two general spill-size categories: (1) large spills, those greater than or equal to (≥) 1,000 bbl, meaning that 1,000 bbl is the threshold size and (2) small spills are < 1,000 bbl. A major difference between the two size categories is that the oil-spill-trajectory model addresses the movement of large spills ≥1,000 bbl. The oil-spill-trajectory model results are appropriate only for "large" spills ≥1,000 bbl, because they are large enough to persist on the water and be followed through time. Small spills are analyzed without the use of the oil-spill-trajectory model, because they break up and dissipate within hours to a day.

The oil-spill analysis considers two general operation categories: (1) exploration and (2) development and production. A major difference between the two categories is that crude oil is not part of the exploration scenario.

The information about these hypothetical spills includes estimates of the source of accidental spills that may occur, how many spills, their sizes, where large spills might travel to, and how they might weather. We use a consistent set of assumptions about these spills to analyze the impacts to social, economic, and environmental resources from oil spills in Sections 4.4 and 4.5 of the DEIS.

4.3.2.1. Large Oil Spills. This section summarizes the assumptions we use to analyze large oil spills during development and production in both sale areas for the Proposed Action. The section locations for the analysis of small and large spills are shown in Section 4.3.2.3, Locations of Oil-Spill Analyses. We define large oil spills as ≥1,000 bbl. This means that 1,000 bbl is the minimum threshold size. The difference in terminology and size categories between the MMS term large and the USCG terms moderate and major are:

Moderate	Large	Major

USCG	238-2,380 bbl	2, 381 bbl or greater
USDOI, MMS		1,000 bbl or greater

The assumptions about large oil spills are derived from a mixture of project-specific information, modeling results, statistical analysis, and professional judgment. The technical details of these points are in Appendix A of the DEIS. The technical basis for understanding the assumptions about large oil spills used in the effects analysis on environmental, social, and economic resources of concern are in Sections 4.4 and 4.5 in the DEIS.

4.3.2.1.1. Estimated Mean Spill Number for Development and Production. First we estimate a mean number of development and production spills to estimate how many oil large spills should be assumed for analysis. In the case of both the future Beaufort Sea Sales 209 and 217 and Chukchi Sea Sales 212 and 221, the estimated mean spill number over the life of production is less than one. For purposes of analysis, we assume one large spill occurs at any location open to leasing in the full Proposed Action area. This "what-if" analysis of a large oil spill addresses whether such large spills could cause serious environmental impact.

For elements of the Proposed Action pertaining to the Beaufort Sea, statistically we estimate a total mean spill number of 0.30 (one third of a spill) over the 20-year production life. The MMS considers this number to be low, because adding both annual pipeline and platform fractional spill estimates over a twenty year production life statistically is less than one spill. For elements of the Proposed Action pertaining to the Chukchi Sea, statistically we estimate a mean spill number of 0.51 (half a large spill) over the 25-year production life. The MMS considers this number to be low.

4.3.2.1.2. Assumed Large Spill Sizes. To evaluate the effects of a large oil spill in a consistent manner, we estimate large spill sizes for a platform or a pipeline. The large spill-size category is for spills ≥1,000 bbl. This means the spill can be 1,000 bbl or larger and fall within the large spill-size category.

For the Proposed Action, we assume a large spill size based on median OCS platform or pipeline spill sizes (Anderson and LaBelle, 2000). Appendix A, Tables A.1-1 and A.1-2 of the DEIS, show the large spill sizes we assume for purposes of analysis range from 1,500-4,600 bbl for crude, diesel, or condensate oil. The assumed large spill sizes are broken out as follows:

Production facility (includes storage tanks)

- 1,500 bbl, crude, diesel, or condensate oil or

Offshore pipeline,

- 4,600 bbl, crude or condensate oil

In terms of timing, a large spill from the Proposed Action could happen at any time during the year. We assume that the production facility would not retain any oil. The analysis of containment or cleanup is considered mitigation and is analyzed in Sections 4.4 and 4.5. We assume that, depending on the time of year, a spill reaches the following environments:

- production facility and then the water or ice
- open water
- broken ice
- on top of or under solid ice
- shoreline
- tundra or snow

4.3.2.1.3. Large Spill Weathering. The analysis of a large spill examines the weathering of the assumed spill sizes. We assume the oil will be similar to Alaska North Slope or Alpine Composite crude oil. We use a typical diesel fuel for diesel and a condensate called Sleipner. The spill sizes are 1,500 or 4,600 bbl. We simulate two general scenarios: (1) the oil spills into open water and (2) the oil freezes into the ice and melts out into 50% ice cover. For open water, we model the weathering of the 1,500- and 4,600-bbl spills as if they were instantaneous spills. For the meltout-spill scenario, we model the entire spill volume as an instantaneous spill. Although different amounts of oil could melt out at different times, we took the conservative approach, which was to assume all the oil was released at the same time. We report the results at the end of 1, 3, 10, and 30 days.

In our analysis, we assume the following fate of the crude, diesel, or condensate oil without cleanup. Appendix A.1, Tables A.1-6 through A.1-12, summarize the results we assume for the fate and behavior of crude, condensate, or diesel oil in our analysis of the effects of oil on environmental and social resources. Condensate and diesel oil will evaporate and disperse much more rapidly than crude oil, generally within 1-10 days. After 30 days in open water or broken ice, we assume the following weathering for crude oil:

- 27-40% evaporates,
- 4-43% disperses, and
- 28-69% remains.

After 30 days under landfast ice:

- nearly 100% of the oil remains in place and unweathered.

4.3.2.1.4. The Chance of One or More Large Spills Occurring. The chance of one or more large spills occurring over the 20-25 year production life does not factor in the chance that a development project occurs. Given the many logistical, economic, and engineering factors, there probably is a 10-20% chance per sale that a commercial field will be leased, discovered, and developed. However, because leasing and exploration could lead to a development project, MMS evaluates what would happen if a development occurred. The probability of a development arising from five sales in the Beaufort Sea is, based on a 20% probability of success for each sale, calculated to be 67%. The chance of a development occurring in the Chukchi Sea is, based on a 10% probability of success for each of three sales, calculated to be 27%.

For the Proposed Action, our estimate of the chance of one or more large spills occurring assumes there is a 100% chance that a project will be developed and 0.5 or 1 billion barrels (Bbbl) of oil will be produced from the Beaufort Sea or Chukchi Sea, respectively. If a development occurs, this oil-spill analysis more accurately represents the chance of one or more large spills occurring.

Beaufort Sea. The chance of no large pipeline spills occurring is 86%, and the chance of one or more large pipeline spills occurring is 14% for the Proposed Action, over the 20-year production life. 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 annual platform and pipeline mean number of large 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.

Chukchi Sea. The chance of no large pipeline spills occurring is 74%, and the chance of one or more large pipeline spills occurring is 26% for the Proposed Action, over the 25-year production life. 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% for the Proposed Action, over the 25-year production life. The total is derived from the sum of the annual platform and pipeline mean number of spills over the entire 25-year production life. The chances of no large 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.

4.3.2.1.5. The Chance of a Large Spill Contacting Environmental Resource Areas. We estimate the chance of a large spill contacting social, environmental, and economic resources of concern from an oil-spill-trajectory model. The results of those trajectory calculations are found in Appendix A.2 of the DEIS for the Beaufort Sea and Appendix A.3 for Chukchi Sea.

4.3.2.1.6. The Chance of One or More Large Spills Occurring and Contacting Environmental Resources Areas. We also estimate the chance of one or more large spills occurring and contacting resources of concern over the production lifetime of the project. For Beaufort Sea after 30 days, the chance of one or more large spills occurring and contacting environmental resource areas (ERAs), land segments (LSs), or boundary segments ranges from <0.5-4%. For Chukchi Sea after 30 days, the chance of one or more large spills occurring and contacting ERAs, LSs, or boundary segments ranges from <0.5-13%.

4.3.2.1.7. Large Spill Assumptions Summary. We base the analysis of effects from large oil spills from the Proposed Action on the following assumptions:

- No large spill occurs during seismic operations or exploration drilling.
- One large spill occurs during development and production.
- The large spill size is 1,500 or 4,600 bbl.
- All the oil reaches the environment; the production facility absorbs no oil.
- The oil types could be crude, diesel, or condensate.
- The spill starts at the production facility or along the offshore pipeline.
- There is no cleanup or containment; cleanup is analyzed separately as mitigation.
- The large spill could occur at any time of the year.
- The spill weathering as summarized above and in DEIS, Appendix A.1, Tables A.1-6 to A.1-12.
- A large spill under the landfast ice or a spill that moves into the landfast ice from the production facility or its pipeline does not move significantly until the ice breaks up (DEIS, Appendix A.1).
- The large spill area varies over time as we show in DEIS, Tables A.1-6 to A.1-12 and is calculated from Ford (1985).
- The time and chance of contact from a large oil spill are estimated from an oil-spill-trajectory model (DEIS, Appendix A, Tables A.2-1 through A.2-156, or Tables A.3-1 through A.3-78).
- The chance of contact is analyzed from the location where it is highest when determining impacts.
- The overall chance of one or more large oil spills occurring and contacting (an ERA, LS, BS, or GLS) is calculated from an Oil-Spill-Risk Analysis (OSRA) model (DEIS, Appendix A, Tables A.2-157 through A.2-161, or A.3-79 through A.3-83).

Small Oil Spills. Small spills, although accidental, generally are routine and expected. Small spills can occur from both exploration and development. The majority of small spills generally are into containment and do not reach the environment. We estimate small spills are likely to occur.

<u>Exploration:</u> Small fuel spills associated with the vessels used for seismic exploration might occur, especially during fuel transfer. For purposes of analysis, we assume a seismic vessel transfer spill is 5 gallons (gal).

Small spills could also occur during exploration drilling operations. We assume a 25 bbl spill per well during exploration drilling operations. Historically, all but <3 bbl of the total amount spilled was recovered during spill response (Section 1.1.5, Appendix A, DEIS), an average of 3.2 gal spilled per well drilled.

Development: The analysis of onshore Alaska North Slope crude oil spills is performed collectively for all facilities, pipelines, and flowlines. For analysis purposes, we assume an average crude oil-spill size of 3 bbl (ADEC, 2001).

Following is the estimated number and volume of small crude oil spills during development and production:

	Estimated Number of Spills	Estimated Total Spill Volume (barrels)
Beaufort Sea	89	267
Chukchi Sea	178	534

The causes of onshore Alaska North Slope crude oil spills, in decreasing order of occurrence by frequency, are leaks, faulty valves/gauges, vent discharges, faulty connections, ruptured lines, seal failures, human error, and explosions. The reported cause of approximately 30% of the spills is unknown (ADEC, 2001).

The typical refined products spilled are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil (ADEC, 2001). 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. For analysis purposes, we assume an average refined-spill size of 0.7 bbl. Following is the estimated number and volume of refined spills:

	Estimated Number of Spills	Estimated Total Spill Volume (barrels)
Beaufort Sea	220	154
Chukchi Sea	440	308

4.3.2.3. Locations of Oil-Spill Analyses. Following are section locations for the analysis of oil spills and their effects throughout this document:

- Spills could occur in the Beaufort or Chukchi seas from non exploration and production activities or from oil and gas activities in State waters or from existing offshore production facilities such as Endicott, Northstar, or Oooguruk. Spills also possibly could occur elsewhere due to production elsewhere in the United States or from import tankering to meet the demand for oil and gas.
- Appendix A.1 - supporting documentation for the assumptions we use in the oil-spill analysis are in the DEIS.

For more information on the analysis of oil spills, see Appendix A.1 of the DEIS.

4.3.3. Oil-Spill Response.

4.3.3.1. Oil-Spill-Contingency Measures.

4.3.3.1.1. Federal Laws. Environmental protection from oil spills is regulated under the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300) as required by Section 105 of the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA), 42 U.S.C 9605 as amended by the Superfund Amendments and Reauthorization Act of 1986, Public Law (P.L.) 99-499 and by section 311(d) of the Clean Water Act (CWA), 33 USC 1321(d) as amended by the Oil Pollution Act of 1990 (OPA), P.L. 101-380.

Section 311 of the CWA provides the overall regulatory framework for oil spills and designated hazardous substances, including national policy and responsibilities. Policy specific to oil spills is further defined in OPA. Under OPA, liability for actual costs of removal rests with the spiller. The OPA establishes oil-spill-response planning and preparedness requirements for offshore facilities. Executive Order 12777 implementing OPA assigned regulatory oversight for offshore oil and gas to the Department of the Interior, which assigned those tasks to MMS.

The CERCLA significantly broadens the scope of spill reporting and response. It specifically requires spillers to immediately notify the National Response Center in the event of a release of a reportable quantity of a hazardous substance to the environment and sets penalties in place for failure to provide notification as required.

The Resource Conservation and Recovery Act (RCRA) addressed issues pertaining to hazardous-waste management. The RCRA requires an EPA identification number for generators, transporters, and disposers managing hazardous waste generated in the course of oil-spill-response activities and use of appropriate hazardous-waste manifests creating a "cradle-to-grave" audit trail to ensure proper disposal at an approved treatment, storage, and disposal facility.

4.3.3.1.2. National and Regional Contingency Plans. The National Contingency Plan (NCP) and the Alaska Federal and State Preparedness Plan for Response to Oil and Hazardous Substance Discharges and Releases (Unified Plan) have been developed in compliance with the CWA, Section 311(c)(2); CERCLA, Section 105; and OPA, Section 1321(d). In addition to the Unified Plan, Alaska has divided the State into 10 geographic regions and developed subarea contingency-response plans for each area. The North Slope Subarea Contingency Plan addresses specific response issues for the northern Chukchi Sea. These plans include sections that identify spill-sensitive biological and cultural resources and geographic response scenarios, which identify shoreline types in the subarea and lists spill-response tactics that can be used to protect those areas. Subarea contingency plans provide for coordinated and integrated response by departments and agencies of the Federal and State governments to protect human health and the environment and to minimize adverse effects due to oil and hazardous substance discharges.

Responsibility for developing the regional contingency plan rests with the Regional Response Team (RRT) for that area. The Alaska RRT (ARRT) is composed of representatives from USCG, EPA, and State of Alaska as co-chairs of the ARRT, and the following Federal departments: Agriculture, Commerce, Defense, Energy, Health and Human Services, Homeland Security, Interior, Justice, Labor, and State. The ARRT provides the appropriate regional mechanism for planning and preparedness activities before a response action is taken and for coordination and advice during an event.

Under the NCP a Federal On-Scene Coordinator (FOSC) is pre-designated by the EPA or the USCG to provide on-scene coordination and direction of all aspects of a spill and subsequent removal actions. For spill events occurring on the OCS, the USCG will act as the FOSC. The FOSC maintains a responsibility to ensure that the proper initiation of containment countermeasures, cleanup, and disposal actions take place. The State of Alaska also pre-designates a State On-Scene Coordinator (SOSC) to carry out similar duties for the State. A Local On-Scene Coordinator (LOSC) representing the NSB also ensures that local concerns are addressed during a spill response. The FOSC, SOSC, and LOSC will join the Responsible Party On-Scene Coordinator, representing the operator, and form a Unified Command (UC), which will direct the spill response. The UC jointly establishes goals and objectives, ensures that agency priorities are addressed, and produces a single-incident-action plan to respond to the spill.

In the event the FOSC determines that spill-response efforts by the responsible party are inadequate to properly respond to the spill, the FOSC has the authority to "federalize" the response and use Federal assets to continue cleanup activities. The responsible party is financially liable for the costs incurred from a Federal response.

4.3.3.1.3. Joint Contingency Plan Combating Pollution in the Bering and Chukchi Seas. This plan, including the operational appendix, was established under the agreement between the Government of the United States and the Government of the Union of Soviet Socialist Republics (USSR) concerning cooperation in combating pollution in the Bering and Chukchi seas in emergency situations. [**Note**: This agreement has been updated to reflect the change from the USSR to the Russian Federation.] The plan primarily addresses international matters and is intended to augment pertinent existing plans. The implementation of this plan is the joint responsibility of the USCG (Department of Homeland Security) and the Russian Federation Marine Pollution Control and Salvage Administration, attached to the Ministry and Merchant Marine.

4.3.3.1.4. MMS Pollution-Prevention and -Response Regulations. Pollution-prevention regulatory requirements for oil, gas, and sulphur operations in the OCS are found in 30 CFR 250, Subpart C – Pollution Prevention and Control. These regulations require operators that engage in activities such as exploration, development, production, and transportation of oil and gas prevent unauthorized discharge of pollutants into the offshore waters. The operators shall not create conditions that will pose unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean. These regulations further mandate daily inspections of drilling and production facilities to determine if pollution is occurring. If problems are detected, maintenance or repairs must be made immediately.

Oil-spill contingency-planning requirements are provided in 30 CFR 254 – Oil-Spill Response Requirements for Facilities Located Seaward of the Coast Line. These regulations implement the requirements established by the OPA. Every operator operating seaward of the coastline, whether in State or Federal waters, is required to submit an oil-spill-response plan (OSRP) for their facilities to MMS for approval. Required components of the OSRP include: introduction and plan contents; emergency-response-action plan; equipment inventory; contractual agreements for spill-response services; worst-case discharge scenario; dispersant-use plan; in situ burning plan, and a training and drills plan. Plans are required to be reviewed and updated every 2 years or when there is a significant change that negatively impacts response capabilities. Critical requirements for each plan segment are described below.

4.3.3.1.4.1. Introduction and Plan Contents. This section of the OSRP requires the operator to identify the facilities covered by the plan, including location and type, a table of contents, a record of changes made to the plan, and a cross-reference table if an alternate format is selected.

4.3.3.1.4.2. Emergency Response Action Plan (ERAP). In this section, the operator will designate, by name or position, a trained Qualified Individual who has full authority to implement the plan and commit company resources to respond to a spill, a trained spill-management team, and a trained spill-response-operating team, all of which are available on a 24-hour basis. They must identify the planned location for a spill-response-operations center as well as provisions for primary and secondary communication systems for coordinating and directing spill-response operations. This section also must include a list of procedures to be followed in the event of a release, along with a list of Federal, State, and local agencies to be notified in the event of a spill and the contact information for any oil-spill-removal organizations (OSRO) cited in the plan. Other elements of the ERAP include:

- spill notification procedures;
- methods to predict and monitor spill movement;
- methods to identify, prioritize, and protect beaches, waterfowl, and other marine and shoreline resources in the affected area of special economic or environmental importance;

- methods to ensure containment and recovery equipment and response personnel are mobilized and deployed at the spill site;
- methods to ensure that storage devices for recovered oil are sufficient to ensure uninterrupted containment and recovery operations
- procedures to remove oil and oiled debris from shallow waters and shoreline and collect and rehabilitate waterfowl that has become oiled;
- procedures to store, transfer and dispose of recovered oil and oil contaminated materials in accordance with applicable Federal, State, and local requirements; and
- methods to implement dispersant and in situ burning plans.

4.3.3.1.4.3. Equipment Inventory. This section must include a listing of spill-response materials and supplies, services, equipment, and response vessels available locally and regionally. Contact information for each supplier must be provided. A description of inspection and maintenance procedures also must be provided.

4.3.3.1.4.4. Contractual Agreements. The operator must provide copies of contracts or membership agreements with OSROs, cooperatives, spill-response-service providers, or spill-management-team members cited in the plan who are not company employees. These agreements must include provisions for ensuring the availability of the personnel and/or equipment on a 24-hour basis.

4.3.3.1.4.5. Worst-Case Discharge Scenario. The worst-case discharge scenario is a narrative that identifies response actions to be taken should a worst-case discharge event of oil occur. For exploration and development drilling operations, this volume is the daily volume possible from an uncontrolled blowout, and the scenario must discuss how the operator would respond to the well flowing for a period of 30 days. The scenario must include all of the components listed under the ERAP. In developing the scenario, the operator must provide an appropriate trajectory analysis specific to the area in which the facility is located and include a discussion of adverse weather conditions that may be encountered in the operating area such high winds, broken ice, and extreme temperatures.

4.3.3.1.4.6. Dispersant-Use Plan. Operators are required to provide a dispersant-use plan that is consistent with the National Contingency Plan Product Schedule and consistent with national and area contingency plans. The plan must include an inventory and location of dispersants and other chemical or biological products that could be used on the oils handled, stored, or transported at the facility. In addition, the plan must include information on chemical toxicity data, types and location of application equipment, application procedures and conditions under which the chemicals may be applied, and an outline of procedures to be followed to obtain approval for product use.

Dispersant-use plans currently are not included in offshore North Slope spill-response plans because of the shallow depths where the activities occur. All but one of the current offshore facilities are located in <10 m of water, which generally precludes the use of dispersants due to concerns over toxicity in the nearshore environment.

4.3.3.1.4.7. In Situ Burning Plan. The in situ burning (ISB) plan likewise must be consistent with national and area contingency plans. The plan must provide a description of burn equipment, including location and availability; a discussion of ISB procedures, including provisions to ignite the oil; a discussion of environmental effects of the burn; guidelines for well control and safety of personnel and property; a discussion of when ISB may be appropriate and guidelines for making the decision to ignite; and an outline of procedures for gaining approval for an ISB.

4.3.3.1.4.8. Training and Drills. The MMS requires that members of the operator's spill-response team who are responsible for operating response equipment attend hands-on training classes, include the deployment and operation of the response equipment they will use, at least annually (30 CFR 254.41). The operator is required to identify and include dates of training provided to members of the spill-response-management team and qualified individuals. Types of training given to the members of the spill-response-operating team must be described and must include: locations, intended use, deployment strategies and operational and logistical requirements for response equipment, spill-reporting procedures, oil-spill-trajectory analysis and predicting spill movement, and any other specific responsibilities the team may have. Records of all training must be maintained and available for inspection by authorized MMS personnel for a period of 2 years.

The operator also must conduct a series of exercises and deployment drills over a 3-year period to exercise all aspects of the OSRP (30 CFR 254.42). The operator must conduct an annual tabletop exercise to test the spill-management team's organization, communication, and decision-making in managing a response; an annual deployment exercise of response equipment identified in the plan, and each type of equipment must be deployed and operated during the 3-year period; an annual notification exercise for each facility manned on a 24-hour basis; and a semiannual deployment exercise of any response equipment that the MMS requires an owner/operator to maintain on site.

During the course of the exercises, conditions that exist in the area of operation must be simulated, including seasonal variations. Exercises must cover a range of scenarios simulating responses to large continuous spills, spills of short duration and limited volume, and the worst-case discharge. All records of spill-response exercises must be maintained for the complete 3-year exercise cycle and must be available for inspection by authorized MMS representatives.

Most operators use the National Preparedness for Response Program (PREP) for planning and conducting response exercises and drills. The PREP is a unified Federal effort and satisfies exercise requirements for the MMS, USCG, EPA, and RSPA Office of Pipeline Safety. Elements of the program are provided in the PREP Guidelines, which can be found on the USCG web site at http://www.uscg.mil/hq/g-m/nmc/response/msprep.pdf. The program includes a series of internal and external exercises that must be conducted over a 3-year period. Internal exercises are designed to examine and test the various components of a response plan to ensure the plan meets the needs of the operator. The external exercises are designed to examine the response plan and the plan holder's ability to coordinate with the response community to conduct an effective response.

In addition to operator exercises, MMS periodically will initiate both announced and unannounced drills to test the operator's spill-response preparedness. If, in the course of the drills, MMS determines that plans are inadequate, the operator will be required to modify the plan to address deficiencies in response equipment, procedures, and/or strategies.

4.3.3.1.5. Industry Oil-Spill-Response Planning and Response. Oil-industry operators are required, per 30 CFR 250 Subpart B – Plan and Information, to submit to MMS for approval an OSRP with any exploration, development, or production plan. The plan must address all requirements cited in 30 CFR 254 plus any additional information required under the lease-sale stipulations. Operators may use the format provided in the regulations or another format of their choosing, as long as informational requirements are met and cross-referenced to the regulations.

4.3.3.1.5.1. Oil-Spill-Trajectory Analysis. Oil-spill models that use historical current, ice, and wind data help establish the range of possible scenarios and are very useful in spill-response planning. Estimating oil-spill-trajectories is desirable, because it gives some approximations on where oil spills are likely to contact shoreline or sensitive resources, and where potential shoreline contamination could occur. Identifying where slicks may move can aid in staging oil-spill-response equipment to expedite deployment and in effective response actions, such as protective booming of sensitive areas, oil containment and spill cleanup, and for oil-spill contingency-planning purposes.

During an actual spill, oil-spill trajectories, provided by the National Oceanographic and Atmospheric Administration (NOAA), can aid in effective oil-spill-response actions by helping to answer questions regarding what resources are at risk and when they are at risk. This can help managers effectively ration and distribute manpower to maximize the effectiveness of the spill-response and -cleanup effort.

4.3.3.1.5.2. Early Leak Detection and Tracking. Daily pollution inspections of drilling and production facilities are required under 30 CFR 250.301 to check for leaks or situations that could result in leaks. Repair or maintenance needs are required to be initiated immediately should pollution or threat of pollution be discovered. Records of these inspections and any maintenance and repair actions are required to be maintained at the facility for a period of 2 years.

The MMS currently has no leak-detection system requirements for subsea pipelines. In more temperate climates, pipeline leaks usually can be detected by oil sheens on the ocean surface during routine flights between the shore and offshore platforms. In Alaska, this becomes problematic during winter when the ocean surface freezes, obscuring from view any potential releases. Portions of pipelines also may be obscured from view, because they must be buried as they enter shallow waters to protect them from ice gouges and strudel scours. Alternate methods for leak detection need to be employed to increase the likelihood of early detection and prevent a small leak turning into a large spill as the ice melts.

One existing leak-detection system is the LEOS (Leck Erkennung Ortungs System) used on BPXA's Northstar pipeline, which has the capability to detect about a 1 bbl release in 24 hours. LEOS is strapped to the exterior of the pipeline and detects leaks by collecting vapors through a liquid impermeable acetate layer within a perforated tube. The collected vapors are screened every 24 hours for specific hydrocarbon compounds that, if detected, could indicate the pipeline has begun to leak. Whether this type of system could be made to work on a much longer pipeline in the Chukchi Sea is unknown. There are several new technologies and techniques that are under development, such as continuous strain measurement, self-healing pipelines, new types of smart pigs, etc., that likely will be available in the future. Before any pipeline is permitted, there will be an environmental review where these and many other issues will be analyzed.

Another method of leak detection used by BPXA for their Northstar pipeline during solid-ice conditions involved drilling holes through the ice at various intervals along the pipeline route, on a monthly basis, to look for any oil that may have leaked from the pipeline. Through-ice monitoring was used as a supplemental detection method in the event the prototype LEOS system failed to operate. This method of leak detection is labor intensive and presents significant safety hazards to the personnel from weather and polar bears, with no guarantee that the holes drilled through the ice would be over a leak. The requirement for drilling the holes was dropped once the LEOS system was proven to provide adequate leak detection.

Research also is continuing on remote sensing of spills in solid- and broken-ice conditions. Ground-penetrating radar (GPR) has proven effective in locating oil under solid ice in experiments conducted in Norway (Dickins et al., 2006). Additional research has been funded to investigate the technical feasibility and cost of developing and incorporating airborne oil-detection systems using GPR in future field trials with oil and ice.

In the event of a spill, it is essential to be able to track the oil as it moves in the environment so that response assets can be directed to the correct location. It also is critical to be able to track oil that becomes encapsulated in ice due to a spill that occurs as the ocean begins to freeze or occurs during solid-ice conditions. This tracking is accomplished through the use of radio-outfitted tracking buoys that are deployed into the water or ice and move with the oil. The buoys consist of a GPS receiver, an antenna, and a beacon outfitted with a transmitter that provides status reports via email to the response-command center.

Tracking of an oil spill during open water conditions can be accomplished from aircraft flying over the spill area. During overflights, forward looking infrared (FLIR) videotape images are taken. Thicker areas of oil within the slick emit more thermal radiation and appear as white or hot spots on the images. The FLIR system works day or night. Tracking buoys also may be deployed to aid in spill tracking. The buoys used in open-water conditions are deployed from vessels, and the receiver is placed in an aircraft or vessel.

4.3.3.1.5.3. Recovery Equipment. Mechanical containment and recovery is the most commonly used and most environmentally acceptable response technique to clean up oil spills in the United States. Mechanical spill response uses physical barriers (containment booms) to contain and concentrate floating oil, and mechanical devices (skimmers) to remove oil from the water's surface, and temporary storage devices to store the recovered oil and water until it can be disposed of properly. Mechanical collection of oil is an effective means of recovery for oil of varying viscosities and emulsification ranging from 1,000-20,000 centipoise (cP) (Broje and Keller, 2006). Where feasible and effective, this technique is preferable to other methods, because spilled oil is removed from the environment to be recycled or properly disposed of.

To determine the minimum amount of equipment required, operators must calculate their effective daily recovery capacity of the response equipment they select to ensure they have sufficient capacity to contain and recover their worst-case discharge volume. Recovery capacity is calculated by multiplying the manufacturer's rated throughput capacity of the equipment over a 24-hour period by 20%. In essence, a hypothetical skimmer that has a nameplate capacity of 1,000 bbl of throughput per day would be credited with only 200 bbl throughput capacity/day for planning purposes. Application of this derating factor is intended to take into account periods when recovery operations are limited due to daylight, sea state, frigid temperatures, ice, and viscosity and emulsification of the oil being recovered.

Skimmers of choice for arctic waters are oleophilic brush, rope mop, or drum/disc skimmers that collect oil through adhesion. The oil adheres to the surface of the brush or rope which is then scraped off into a sump and pumped to a storage tank. These skimmers are very efficient in recovering oil while limiting the amount of water collected, extending on-water storage. The types of oil that a brush skimmer can recover depend on the stiffness and density of the bristles used as well as the comb configuration. Generally speaking, finer, softer bristles are better for light oil whereas a stiffer, wider spaced bristle is better for heavy oil. The skimming surface can be changed out with relative ease to meet with changing oil properties.

These skimmers can be used in a static configuration along an ice edge or in melt pools on top of the ice surface or in an advancing configuration where the skimming vessel moves forward into the slick. In open water and limited broken-ice conditions, advancing skimming systems will be the predominant configuration, because vessels can move freely to access floating oil. Static skimming systems are used in higher ice concentrations or in shallow waters, where the oil is more likely to pool and be less affected by winds and currents.

The other type of skimmer used is a weir skimmer, which floats in the oil and pumps the oil to the storage unit. These skimmers recover a much higher percentage of water, requiring more on-water storage capacity. The effectiveness of these skimmers is closely tied to the operator's skill and experience in being able to keep the skimmer properly positioned at the oil/water interface, allowing only oil to enter the weir.

Mechanical recovery of oil can be limited by extreme weather conditions and the presence of ice. In conditions where waves exceed 6 ft, mechanical recovery becomes ineffective; oil is splashed out of containment devices and skimmers cannot maintain contact with the oil, as vessels pitch and roll with the waves. Ice likewise will reduce or preclude the use of skimmers and boom. During freezeup conditions, ice crystals forming on the ocean surface can create a barrier around skimmers effectively preventing the flow of oil to the skimmer. The addition of containment booms in these conditions concentrates both oil and slush, accelerating this effect. In early breakup conditions, use of containment boom is limited due to large pieces of ice that can destroy the boom and damage skimmers and vessels.

On-water storage capability will be a critical component of an oil-spill response in the Chukchi Sea. Once storage vessels are full, mechanical recovery operations must stop. The operator must have sufficient capacity to hold recovered oil from the worst-case discharge plus additional capacity to account for water recovered during skimming operations and from emulsified oil. It is unlikely that the operator will be able to lighter recovered fluids to shore for processing and disposal during the spill response to free up storage capacity, so larger storage vessels will be required. Shell Offshore, Inc. has contracted for an ice-strengthened oil tanker with storage capacity of 513,000 bbl to hold recovered fluids from a worst-case discharge from their Beaufort Sea operations. Shell has twice the required storage needed to meet their storage needs, which should allow recovery operations to continue until active skimming operations are stopped by the FOSC, at which time the tanker would transit to a port to unload and dispose of their wastes.

4.3.3.1.5.4. Available Spill-Cleanup Equipment. Oil-spill-response equipment dedicated to oil-industry spill response on the North Slope is located primarily in Deadhorse, Alaska. Fifty percent of the equipment is owned and maintained by Alaska Clean Seas (ACS), an OSRO cooperatively owned by North Slope oil producers, and the remaining 50% is owned directly by North Slope operators. All this equipment is available in the event of a spill through the Mutual Aid Agreement (MAD) established between operators on the North Slope. Signatories to the MAD agree to provide both equipment and personnel for the initial spill-response activities until the responsible party can mobilize their out-of-region resources to respond. This ensures response actions are initiated immediately.

Because the majority of North Slope activities occur onshore or relatively close to shore, ACS specializes in nearshore and limited offshore oil-spill response and holds USCG classifications for M, W1, and W2 response levels. Classification levels are issued based on the amount of response equipment, recovery capacity, temporary storage capacity, and response times for a geographic area. An OSRO must meet the minimum criteria in all categories to receive a rating for a specific level. The Coast Guard's OSRO classification program is a voluntary program where OSROs submit documentation regarding their equipment and response capabilities for review and verification by the USCG. Table 4.3.3-1 of the DEIS provides definitions and required equipment levels and response times for each classification.

Shell Offshore Inc. also has formed an OSRO to supply oil-spill-response services for their operations on the Beaufort Sea OCS. Their OSRO, ASRC Energy Services (AES) is providing open-ocean and offshore spill-response services. At the time of the DEIS being prepared, AES had applied for USCG classification but had yet to complete the process. The AES will operate a purpose-built oil-spill response vessel with 11,400 bbl of storage capacity, and an oil-spill response barge, with 16,800 bbl of storage capacity, to support Shell drilling rigs during the open-water season in the Beaufort Sea. The vessels will be maintained onsite while drilling operations are going on to provide immediate spill response. In addition to the response barges, AES has a number of smaller vessels that will operate skimming systems and a 513,000-bbl oil tanker for on-water storage for recovered oil.

The North Slope Subarea Contingency Plan contains a section that identifies major resources and quantities of response-related equipment that may be available within the subarea. The listing also identifies resources available from outside the immediate area, as a significant spill event most likely would require resources from other locations. This plan was updated in April 2007. This inventory is inclusive of both private and Federal response resources.

Additional out-of-region equipment maintained across the country could be available through an Association of Petroleum Industry Co-op Managers MAD to provide equipment and personnel on an as-available basis. There are four other OSROs within Alaska that can provide additional equipment and personnel support if approved by the SOSC.

4.3.3.1.5.5. Nonmechanical Response. As stated above, mechanical containment and cleanup is the preferred method of spill response, because it removes the spill from the environment. However, if conditions limit or preclude the use of mechanical means, operators are required to have plans in place to use nonmechanical response methods, such as ISB and dispersants. Each of these response methods serve to reduce the impacts of the oil slick on the surrounding environment by changing the properties of the slick. Early application of these methods is critical to their success, as loss of light-end volatile compounds and emulsification of the oil drastically reduce the effectiveness of both ISB and dispersants.

In Situ Burning. An ISB has the potential to remove large quantities of oil from the ocean surface with a relatively minimal requirement for equipment and personnel. In cases of very large spills, it may be the only means to remove oil before a slick can come in contact with the shoreline and impact sensitive populations of birds and mammals. Conversely, ISB does create a large plume of black smoke and particulate matter that may negatively impact humans and other populations downwind from the burn. The residue remaining after the burn may sink and potentially cause negative impacts on benthic organisms in the area.

An ISB involves collecting oil on the ocean surface into a sufficient thickness to support combustion using specially designed containment boom and then igniting it. Fresh oils require a pool of 2-3 millimeters (mm), and emulsions and Bunker C fuels require an oil thickness of 5-10 mm. Burning gasifies the oil during combustion and rapidly changes large quantities of oil into its primary combustion products (water and carbon dioxide), leaving a tarry residue that can be scooped from the water or ice surface for appropriate disposal. This greatly reduces the need for collection, storage, transport, treatment, and disposal of recovered material. In laboratory tests and field use, ISB be has been shown to remove in excess of 90% (ARRT, 1999) of the oil from the ocean surface. The ACS maintains one of the world's largest inventories of fire boom in the world. The reduction in oil volume by ISB is not considered recovery, because the oil is not removed from the environment but physically changed through combustion.

Numerous methods exist for igniting floating oil. Handheld pyrotechnic devices can be armed and tossed into the spill from a helicopter or vessel. If a prepared device is not available, oil-soaked rags, sorbent material, or even a roll of paper towels can be lit and tossed into the slick. When the oil is inaccessible or an intense ignition is required for a large spill area, a helitorch—a helicopter-slung device—can be used to deliver measured quantities of burning gelled fuel to the slick. Like mechanical response methods, ISB becomes useless in heavy seas and high winds, as it is difficult to maintain the required oil thickness and the flames are extinguished. General limitations for conducting an ISB include winds <20 knots (kn), waves <3 ft, and currents <¾ kn relative velocity between boom and water (ACS, 2007).

An ISB is the preferred method of nonmechanical response for ice-infested waters. When ice conditions severely limit or preclude the use of vessel-mounted skimming systems, ISB can be used to access oil located between and on top of icefloes. Broken-ice conditions can enhance the success of ISB by working as a natural containment boom, concentrating oil into thicker pools along the ice edge. The ISB also is an effective tool for removing oil that surfaces through brine channels in the ice sheet as the ice melts in the spring.

Prior to conducting an ISB, the responsible party must submit an Application for ISB to the FOSC and SOSC for approval. The application requires the applicant to evaluate the current response situation and determine the need for ISB, determine the feasibility of conducting an ISB, the acceptability of an ISB, and authorizations and conditions required to conduct the ISB. The requirements of the Application for ISB are found in Annex F of the Unified Plan.

Dispersants. Chemical treating agents such as dispersants are another non-mechanical response tool available for offshore response. Dispersants are applied to the surface of an oil slick and work to reduce the surface tension between the oil and water, resulting in a breakup of surface oil slicks. The oil disperses as fine droplets into the water column, so that natural mixing actions will dilute the subsurface oil concentration and subject the oil to natural process, such as biodegradation. If this process is effective, the oil is prevented from moving into sensitive environments or stranding onshore, reducing or eliminating damage to coastal habitats, marine life, or coastal facilities.

Oil dispersants do not reduce the total amount of oil in the environment but change the chemical and physical properties of the oil and change which component of the ecosystem is impacted. In selecting to use dispersants, the benefits of removing the oil slick from the ocean surface must be weighed against the impacts the dispersed oil and dispersant may have on organisms in the water column.

The use of dispersants is a controversial topic in oil-spill response. The early dispersants were derived from engine degreasers and proved extremely toxic to aquatic organisms, causing more damage than the oil spill itself. The toxicity of dispersants presently stockpiled for use in marine waters is low in comparison to that of the petroleum hydrocarbons they are designed to disperse.

Dispersants may be the only available method of response for extremely large spills that cannot be adequately contained and threaten sensitive environments, or when periods of extreme weather are expected and mechanical and ISB response cannot be used. Bad weather can, in fact, improve the effectiveness of dispersants, as the increased wave action mixes the dispersants into the oil slick, accelerating breakup of the slick.

Dispersant application generally is limited by water depth and distance from the shoreline, and its use usually is not permitted in areas where the water depth is <10 m. The ACS and the North Slope operators do not maintain dispersants or application equipment on the North Slope, because offshore activities to date have occurred in relatively shallow waters near shore. Shell's OSRO, AES does have dispersants and equipment listed in their inventory of supplies for their Beaufort Sea activities. Shell's operations will occur in areas where the water depth exceeds 30 m and are >12 mi offshore. Other sources of equipment and materials are available in Alaska, in Anchorage and Valdez, to support spill response for oil tankers transiting the Prince William Sound and Cook Inlet areas, and could be made available in the event of a spill.

It has been widely held that dispersants are ineffective in cold waters like those found in the Chukchi Sea; however, recent research is revealing that dispersants may be an effective tool in responding to spills in cold environments. In 2006, researchers tested the effectiveness of dispersants in cold water. In these experiments, Corexit 9527 dispersant was applied to four Alaskan crude oils in water temperatures ranging from -1 degree Celsius (^{o}C) and +2 ^{o}C with viscosities ranging up from 7,600 cP-69,500 cP at the Ohmsett wave-tank facility in Leonardo, New Jersey during 3 weeks in late February and early March

(S.L. Ross, 2007). The dispersant was applied to fresh and weathered (air sparged) crude oil in high- and low-energy environments. The results of the test indicated that dispersants effectively dispersed 85-95% of the oil in the cold-water environment.

The decision to use dispersants must be made in the early stages of the response, because the longer oil weathers the more resistant it becomes to dispersants. Although there are no dispersants staged on the North Slope, the State of Alaska has one of the best dispersant-use capabilities in the world. There are more than 100,000 gallons of Corexit 9527 stockpiled in the Prince William Sound and Cook Inlet areas along with vessel, helicopter, and fixed-wing aircraft application platforms ready for use in the event of an oil tanker spill. The most likely method of dispersant application in the Chukchi will be by air using a C-130 aircraft coming out of Anchorage. Once mobilized, the aircraft could be over the spill site within 9 hours to apply dispersants (USCG, 2001).

Prior to application of dispersants to an oil slick, the responsible party must submit an Oil Spill Response Checklist: Dispersant Use in Zone 1 and Oil Spill Response Checklist: Dispersant Use in Zones 2 and 3 and in Undesignated Areas for review and approval by the FOSC for Zone 1 and approval by the two Federal Co-Chairs of the RRT (USCG and EPA) and the SOSC after consultation with ARRT members. The Zones are defined by: (1) physical parameter such as bathymetry and currents; (2) biological parameters such as sensitive habitats or fish and wildlife concentration areas; (3) nearshore human-use activities; and (4) time required to respond. Essentially, Zone 1 represents areas that will not be adversely impacted by use of dispersants, such as the open ocean. Zones 2 and 3 represent more sensitive environments, where dispersed oil may have more significant impact on organisms within the water column. During the 2004 M/V *Selendang Ayu* spill in the Bering Sea, dispersant application was requested and was approved by the FOSC for use on the heavy fuel oil IFO 380 leaking from the vessel (State of Alaska, Dept. of Environmental Conservation [ADEC], 2006). Although dispersants were never applied to the spill, the approval action shows a willingness by the ARRT to seriously consider dispersants as a viable response method in Alaska.

4.3.3.1.5.6. Response Time. Previous operators in the Chukchi provided an oil-spill-response barge positioned in close proximity to drilling operations to ensure rapid response to a release. Additional spill-response support for a larger spill most likely would be supplied by ACS in Deadhorse. Most ACS equipment can be mobilized within 2 hours of notification and deployed within an hour of arriving at the spill site. Transportation time of that equipment from Deadhorse to the spill site would depend on the type of aircraft used and weather conditions. Small, fixed-wing aircraft and helicopters located in Deadhorse can transport equipment to villages along the coast in 3 hours or less. Larger fixed-wing aircraft such as a C-130 would have to be mobilized initially from Anchorage to Deadhorse and then transit to Barrow or Point Lay, which are the only villages with landing strips capable of handling the aircraft (ARRT, 2007). Transport times for out-of-regions resources coming from within Alaska and Seattle, Washington are provided in Table 4.3.3-2 of the DEIS. Vessel traffic could arrive from Deadhorse and the Canadian border within 1-3 days. It should be noted that these times do not include the time required to mobilize and load and unload equipment and personnel.

As discussed above, most operators use OSROs to provide oil-spill-response services to meet their obligations under OPA. Most of the OSROs in Alaska providing spill-response services to the oil and gas industry participate in the USCG OSRO Classification program, and they have certified capabilities to mobilize initial quantities of equipment and personnel within 2 hours and be onsite conducting recovery operations within 12 hours. To maintain their current ratings, they will be required to re-evaluate their ability to meet the response-time criteria and may have to stage response equipment and personnel closer to areas of operation. Use of onsite spill response similar to the barge-based response systems used by previous operators in the Chukchi, and the response group planned by Shell for their Beaufort Sea operations would provide for a significant immediate spill-response presence.

For areas of special importance, MMS can require operators to stage equipment at strategic points to allow for more rapid deployment and recovery operations. These requirements would be stipulated in the lease terms and conditions of approval for exploration, development, and production plans.

4.3.3.1.6. Oil-Spill Response at Sea. Effectiveness of a spill response can depend on the source of the spill. The capability to deal with spills from fixed offshore facilities is believed to be better than for tanker spills, because the response planner knows in advance the exact location of the potential discharge and can develop site-specific response actions for the facility. Wind patterns, currents, spill trajectories, priority protection sites, and equipment and manning requirements all can be studied before an event occurs and response personnel can be trained to respond in the specific environment. For blowout-type spills, the oil slick will be concentrated, fresh, and in a non-viscous state, which makes all of the methods of response more effective.

The length of time it will take to complete spill cleanup in the lease area will depend on what time of year a spill occurs. For example, a spill occurring in ice during freeze-up would require an initial onsite response followed by further cleanup in spring and summer, as oil begins to melt out of the ice and pools on top of the ice or between floes. Cleanup continues as long as necessary, without any set deadline or timeframe. A recent example of this is the M/V *Selendang Ayu* fuel-oil spill that occurred in December 2004; the Unified Command declared an end to response actions in June 2006.

Use of mechanical-recovery means alone can recover approximately 20-30% (USCG, 1999) of the oil from a spill. The use of ISB and dispersants further can increase the overall removal of oil slicks from the ocean surface. Effectiveness of an oil-spill cleanup, in large part, is tied to how quickly response and recovery operations can be initiated. The more time that elapses between the spill event and the start of recovery operations allows oil to spread more widely in the environment, increasing the area that can be impacted by the oil, requiring more response resources. The longer the oil remains exposed to the elements, the more weathered it becomes, making it more viscous and more likely to form water in oil emulsions that can limit the effectiveness of skimmers, increase on-water storage requirements, and negatively impact the oil's ability to burn or be chemically dispersed.

An ISB provides another means to effectively remove a large volume of oil from the ocean surface through combustion. It can be employed in open-water and broken-ice conditions using natural and manmade containment. An effective burn can remove in excess of 90% of the collected oil, leaving a tarry residue that can be collected and processed for appropriate disposal.

Chemical dispersion, the use of dispersants to mix oil into the water column versus recovery, is another response technique available to mitigate spill damage. Dispersants begin to lose their effectiveness rapidly as oil weathers and becomes more viscous. As discussed above, recent testing has shown dispersants can have a positive effect on higher viscosity oils, expanding the window in which dispersants can be used.

After oil has impacted the shoreline, a Shoreline Cleanup Assessment Team (SCAT) will systematically collect information on shoreline oiling conditions, identify and describe human use, ecological and cultural resources affected and constraints that they impose on cleanup, cross-check pre-existing information on environmental sensitivities, identify constraints that may limit operations, and provide decision support for onshore response operations. The goal of the SCAT is to develop a clear, accurate understanding of the nature and extent of the oiling, particularly before cleanup begins, to establish response priorities and achieve the greatest level of cleanup while limiting impacts to the area.

Nearshore and shoreline containment and cleanup operations could be either large-scale or moderately sized operations, depending on the particular spill situation. Effectiveness of cleanup in these areas depends on the unique physical characteristics of the environment and the area of operation. Identification of priority protection sites and staging of equipment at key locations in advance of a spill will aid in accelerating response and deploying equipment to limit the impacts of oil on critical areas. Beach cleanup normally is effective using heavy equipment, hand tools such as rakes and shovels, sorbent materials, cold-water flushing, and flooding techniques. Other methods include ISB, application of surfacing washing agents, oil solidifiers, and nutrient enrichment to enhance bioremediation and oil degradation.

4.3.3.1.7. Oil-Spill Cleanup in Ice. The introduction of ice into a spill response can be both a hindrance and a help, depending on conditions and time of year. It is widely agreed that broken-ice environments present significant challenges to conducting an effective cleanup. Ice limits the ability of responders to locate and access oil and presents safety hazards to vessels and personnel. Conversely, ice can aid spill response by limiting the spread of oil in the environment and naturally concentrating oil into thicker slicks that can be more readily skimmed or burned. In situations where ice is forming, it can encapsulate the oil and effectively isolate it from the environment until a response action can be mounted (Dickins and Buist, 1999).

Oil spills occurring in fall as the ocean surface begins to freeze are difficult to recover. The oil becomes entrained in the solidifying grease ice and slush present on the water surface prior to the formation of sheet ice. Rope-mop and foxtail skimmers deployed by crane over the side of a response vessel can recover isolated pools of oil trapped in water and slush but other skimmers, especially weir-type skimmers, will be rendered ineffective rapidly as the slush ice forms a barrier around the skimmer preventing contact with the oil. When conditions no longer permit the use of vessels and skimmers, ISB becomes the next viable method of response. Burns in frazil and slush-ice conditions can be conducted but require thicker concentrations of oil similar to those of a weathered oil (SL Ross, D.F. Dickens Associates Ltd, and Alaska Clean Seas, 2003). Burns can be initiated using a heli-torch or with handheld igniters used by crews transported to the response site by helicopters.

As the ice sheet grows, the oil is fully encapsulated in the ice and will remain there until the ice sheet begins to melt. During the early stages of freeze-up, the band of new-formed ice becomes an effective barrier that protects the shoreline from oiling. At this point, tracking buoys would be placed with the oiled ice so the oil's location can be monitored and recovered at a later date when conditions are more favorable.

Existing response capabilities for landfast ice are more effective than on broken ice or pack ice. Spills on solid ice can be cleaned up using the same techniques and equipment used for terrestrial spills and, depending on the spill, can result in a near-100% cleanup rate. Contaminated ice and snow can be removed from the ice using front-end loaders, bulldozers, road trimmers, snowblowers, shovels, and ISB, just as it would be on land. Use of these methods will be tied closely to ice thickness, stability, bearing capacity, and oil concentrations.

In stable ice conditions, oil spills under ice can be recovered by cutting slots and trenches in the ice above pooled oil, allowing the oil to surface and be collected using skimmers. Larger pools of oil encapsulated within the ice can be accessed by auguring a hole through the ice and pumping the oil out. Oil under ice also may be allowed to surface through brine channels as the ice begins to melt in spring. The oil will collect on the surface of melt pools and can be burned or collected manually. Oil encapsulated in ice remains relatively unweathered, as the ice immobilizes the oil until the ice begins to melt.

Use of ISB of oil during periods of heavy ice is considered one of the more realistic means of responding to a spill in broken-ice conditions. Sea ice works to limit the spread of oil and can concentrate oil between floes and against the ice edge, providing natural containment for an ISB. When conditions are unsafe for vessels or humans on the ice, the oil can be ignited using a heli-torch or handheld igniters tossed into the pooling oil.

Mechanical recovery of oil during spring and summer broken-ice conditions provides additional challenges not present during open water. Response in the Chukchi Sea would require ice-management support from icebreakers or other ice-strengthened vessels to push ice from the path of skimming vessels and provide protection, if necessary. Icebreakers also could be used to break paths to concentrations of oil for recovery or ISB. As the ice breaks up, response options will depend on the rapidly changing ice concentrations. In heavier concentrations, free-skimming operations (smaller vessels outfitted with limited lengths of boom and skimmer) would be more effective than a larger system, because the smaller vessels would be better able to move in and around ice to access pockets of oil. As ice concentrations drop, vessels using larger skimming systems would be able to operate with sufficient ice-management support until open-water conditions returned.

The EPA will not authorize field tests with oil introduced into the operational area, which is the only way to empirically demonstrate actual recovery potential in local conditions. The MMS provided funding for a multinational industry/government sponsored oil-in-ice response test in Norway. The results of this test should provide additional data on spill responses in broken-ice conditions.

There are numerous field-response guides available on the Internet that provide graphic depictions of the response tactics, equipment requirements, deployment considerations, and operational limitations. Three guides of particular interest to cold water climates are described on page 4-31 of the DEIS.

An effective response regardless of the environment relies on careful planning in advance of an incident; having access to the necessary equipment, personnel, and infrastructure to conduct a response; and the ability to act quickly once the event occurs.

4.4. Effects Assessments and Determinations.

ESA-listed Birds.

Summary. In the following analysis, we 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 we describe 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. The MMS-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.

Polar Bear.

Summary. In the following analysis, we determined that negligible or minor effects to polar bears would be likely if the Proposed Action were implemented. Most reasonably foreseeable activities associated with the proposed action, such as open water seismic activities and offshore open water exploration activities, would be likely to have a negligible level of effect. The most likely source of minor effects would be from hazing polar bears away from humans, or activities with the potential to disturb polar bears in dens, such as on-ice seismic operations and winter construction activities associated with exploration or production. Mitigation measures currently in place through the LOA process have proven to be very effective at minimizing such disturbances.

The cumulative effects analysis combines the Proposed Action with all other ongoing trends affecting polar bears in the OCS. The MMS-authorized actions in the OCS could result in a small incremental increase in or longer duration of some activities. In summary, infrequent small petroleum spills are likely to continue to have negligible or minor effects to polar bears. Seismic noise is not anticipated to have more than a negligible or minor effect on polar bears. Subsistence harvest is anticipated to continue at or below sustainable levels in the Alaskan Beaufort/Chukchi seas area and is not expected to be increased by the Proposed Action. An increase in polar bear take in defense of human life could occur as polar bears spend more time on shore due to changing sea ice conditions. Polar bear education and hazing operations implemented by the oil industry as mandated by the FWS have proven to be very effective at mitigating the need for lethal take in the oil fields. Similar programs are being implemented in some villages, which may decrease the necessity for lethal take. Changes in sea ice extent, prey availability and denning habitat as a result of ongoing climate change are the most likely sources of adverse effects to polar bears.

4.4.1. Potential Effects

4.4.1.1. Threatened and Endangered Birds

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." We include the Kittlitz's murrelet and yellow-billed loon in this section because they may eventually be proposed for listing and otherwise warrant special consideration. We often refer to the threatened and candidate species collectively as ESA-listed birds.

The principal sources of potential adverse effects to ESA-listed birds in the Beaufort and Chukchi seas include:

- vessel presence and noise;
- aircraft presence and noise;
- collisions;
- petroleum spills;
- increased bird predator populations;
- increased subsistence-hunting activity;
- habitat loss;
- seismic airgun noise; and
- changes in the physical environment.

4.4.1.1.1. Potential Effects from Vessel Presence and Noise. 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 Area (Figure 3.3.4.2-1) 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. In the most extreme case, an estimated 33,200 spectacled eiders have been counted in the Ledyard Bay Critical Habitat Area (LBCHA) (Figure 3.4.2.1) during the latter portion of the molting season. Most of these eiders are believed to be successfully-breeding females and their hatch-year broods.

While concentrations of molting eiders in the LBCHA 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. Frequent vessel 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. Even a seemingly trivial incremental degree of adverse effect to individual fitness (caused by chronic vessel disturbance) applied to such a large number of molting birds in Ledyard Bay could result in decreased winter survival with resultant decreased population size, productivity, and recruitment.

4.4.1.1.2. Potential Effects from Aircraft Presence and Noise. 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 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 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 km^2 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 km^2 (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-listed birds in the Spring Lead System and the LBCHA.

Altitude restrictions have been used to separate birds and aircraft to reduce the potential to harm eiders (USDOI, MMS, 2006a). 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.

4.4.1.1.3. Potential Effects from 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 LBCHA.

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, 2006a).

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 et al., 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 et al., 2003). 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 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 et al., 2005, 2004). 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 et al., 2005).

Day et al. (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 et al., 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 (Figure 3.3.5-2). 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.

4.4.1.1.4. Potential Effects from Petroleum 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, equipment malfunctions during bulk fuel transfers, and during oil and gas exploration and development. 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 LBCHA are important areas where large numbers of ESA-listed 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 et al. (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 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 renest 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.

Chronic Low-Volume 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, low-volume, chronic oiling is a major cause of seabird mortality.

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.

4.4.1.1.5. Potential Effects from Increased Bird Predator Populations. Predation is believed to be a principal cause for nesting failure. Predators of marine and coastal 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 are unknown, 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.

4.4.1.1.6. Potential Effects from Increased Subsistence-Hunting Activity. Alaskan Natives traditionally have harvested a wide variety of birds on the North Slope. 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). While some waterfowl harvests continue under State and Federal regulations, some species cannot be harvested because their populations have declined to low levels. Hunting of Steller's eiders has been closed for several years, however some accidental harvest was believed to occur through misidentification.

It is unclear if misidentification was the cause of death for 27 Steller's eiders found dead at Barrow between June and August 2008; of these 74% were shot. 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). 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).

4.4.1.1.7. Potential Effects from Habitat Loss. 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 this development.

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

4.4.1.1.8. Potential Effects from Seismic-Airgun Noise. Oil and gas resources need to be identified and delineated before they can be developed. Most often this assessment is completed using seismic techniques. Because seismic surveys completed on land are completed during winter months, direct effects to birds are few. For purposes of analysis, we assess 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 (Richardson et al. 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 anticipated 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 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 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 et al., 2003). Lacroix 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 several 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. Further behavioral observations would be necessary to characterize the response of long-tailed ducks and other birds to seismic surveys, even though the Lacroix et al. (2003) study found no effect of seismic surveying on movements or diving behavior of long-tailed ducks.

While seismic airguns have the potential to alter the availability of marine bird prey, Vella 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.

It is possible that seismic surveys might affect fish and invertebrates in proximity to the airgun array. However, the effects of seismic surveys on marine fish that might change their availability to marine birds have not been documented under field operating conditions (Canadian Department of Fisheries and Oceans [CDFO] 2004). If forage fishes are displaced by airgun noise, birds feeding on those resources might be temporarily displaced and stop feeding within a few kilometers of 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 MMS 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.

4.4.1.1.9. Potential Effects from Climate Change. Scientific and public interest in the Arctic is at an all time high owing to a multitude of warming-induced changes now under way there 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 potential effects influence physical conditions of the spring lead system or the LBCHA are of particular concern. The ESA-listed 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 LBCHA.

4.4.1.1.9.1. 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 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 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. Lehikoinen, 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.

4.4.1.1.9.2. 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.

4.4.1.1.9.3. 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.

4.4.1.1.9.4. 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 [USGS, 2007; 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.

4.4.1.2. Polar Bears

Potential Effects to Polar Bears. This section addresses potential effects to polar bears, a species recently listed as threatened throughout its range under the ESA. Polar bears also are protected under the MMPA. This section refers to the Chukchi Sea (CS) population of polar bears and the Southern Beaufort Sea (SBS) population of polar bears. It is important to note that there is a substantial area of overlap between the two populations, and activities in the western Beaufort Sea and the northern Chukchi Sea would have the potential to impact both populations (DEIS, Figure 3.3.4.3-1).

We describe the potential effects to the polar bear from a variety of currently existing sources without mitigation. We then describe anticipated effects, considering mitigation measures that would avoid or minimize some of these impacts (Appendix 1). These mitigation measures include those that are already in place as conditions (lease stipulations) on existing leases or are anticipated to be in effect on future OCS leases and those that are required through the LOA process under the MMPA.

The principal sources of potential adverse effects to polar bears in the Beaufort and Chukchi seas include:

- vessel presence and noise
- motorized vehicle presence and noise
- subsistence and other harvest
- petroleum spills
- habitat loss and degradation
- seismic noise; and
- changes in the physical environment

4.4.1.2.1. Potential Effects from Vessel Presence and Noise. Most vessel traffic in the Alaskan Arctic occurs near shore and is associated with local fishing and hunting, travel between villages, supply ships and barges serving local villages or the oil industry. Less frequently, cruise ships, icebreakers, U. S. Coast Guard operations, and scientific research vessels operate in the Chukchi and Beaufort seas. With the exception of an occasional icebreaker, traffic at present is limited primarily to summer and early autumn.

Polar bears temporarily may be drawn to or displaced by icebreaker traffic (Brueggeman et al., 1991). In addition, icebreaker activity may alter habitat used by polar bears, particularly when icebreakers take advantage of the lead system to move more easily through ice-infested waters. Polar bears may be stressed by energy expenditures related to avoiding ships or traffic in the lead systems, or conversely, may take advantage of leads opened by ice breakers. Encounters are less likely to occur in open water. Vessels associated with OCS lease exploration include seismic operations in late summer and early fall, and scientific research operations associated with lease areas. Seismic operations in the Chukchi Sea typically include a single source vessel; several support vessels, and occasionally an icebreaker for ice management purposes. 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.) Vessel presence and noise may temporarily disturb small numbers of polar bears during foraging activities.

4.4.1.2.2. Potential Effects from Motorized Vehicle Presence and Noise.
Sources of flights and 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 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.

Polar bears also 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. commun.). 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 or airplane traffic 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 CS 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 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 et al., 2007; Amstrup, 1993). In other instances, polar bears have abandoned dens due to human activities in the vicinity (Perham, 2008, pers. commun.). 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.

4.4.1.2.3. Potential Effects from Subsistence and Other Harvests.
The Southern Beaufort Sea stock of polar nears is harvested by both Alaskan Native and Canadian hunters. On average, 32 bears from the SBS stock are taken annually in Alaska (Angliss and Outlaw, 2005). Current harvest rates of the SBS stock are below the Alaskan harvest quota of 40 animals. As stocks increase or decline, harvest quotas are adjusted through an agreement between the Inuvialuit Game Council and the NSB (see Section 4.4.1.12 of the DEIS).

The Chukchi Sea polar bear population is believed to have increased after harvest was reduced in 1972, but current status and trends are unknown (73 *FR* 28212-28217). The best estimate available at present is about 2,000 (Schliebe et al., 2006). There is a low level of subsistence harvest from this population in Alaska, but there is believed to be a high level of ongoing illegal harvest in Russia. More than 100 bears are thought to be taken annually in Russia and, in some years, the illegal take has been more than 200 polar bears. This level of harvest is not sustainable (Schliebe et al., 2006).

Polar bears are occasionally taken in defense of human life, especially near coastal villages and potentially at industry sites. Two polar bears have been killed as DLP takes in association with industry and military activities, one in 1990 at the Stinson Oil Exploration site, and the other in 1993 at the Oliktok Point Long Range Radar Station. No DLP takes have occurred at industry sites since the Incidental Take Regulations (ITRs) were put in place in 1993, indicating that the mitigation measures associated with the regulations are effective. Polar bear education and hazing operations implemented by the oil industry as mandated by FWS have been very effective at reducing interactions with polar bears in the oil fields and mitigating the need for lethal take. Similar programs have been instituted in some villages along the Chukotka coast with funding and support from World Wildlife Fund. As bears spend more time onshore due to declining sea-ice conditions, there is an increased potential for human-bear interactions (Schliebe et al., 2008). Villagers in some coastal areas have reported more bears coming ashore earlier and staying longer. There have been reports from Fort Yukon and Noorvik of bears wandering much further inland than is usual (Anchorage Daily News 1/5/08, San Diego Union Tribune 3/28/08). In recent years, there also have been reports of cannibalism among adult polar bears, and cubs are at risk from adult male polar bears (Amstrup et al., 2006). When bears become concentrated onshore waiting for the ice to form, there is increased likelihood for intra-specific interactions.

4.4.1.2.4. Potential Effects from Petroleum Spills.

Exposure of polar bears to petroleum or other hydrocarbons could result from a number of ongoing or future events. Petroleum spills may occur as a result of ongoing industry activities, barge and other vessel traffic, accidents at sea, accidents onshore, equipment malfunctions, spills during bulk-fuel transfers, local village activities, or research activities. Most spills are expected to be of refined materials (diesel fuel, gasoline, antifreeze, etc.) and to be very small (DEIS, Section 4.2.1.1.1.3).

Freshly spilled oil contains high levels of toxic aromatic compounds that can cause serious health effects or death if inhaled. Oil that moves some distance from a site still may have high levels of toxic aromatic compounds, depending on temperature and whether the oil becomes frozen into ice. Oil and other petroleum products are highly toxic when ingested. Petroleum products also can foul fur, leading to hypothermia.

Polar bears may come into direct contact with oil, ingest oil while grooming, or ingest oil by feeding on contaminated prey items. Polar bears' coats lose the ability to insulate when fouled with petroleum hydrocarbons. One study found that when two bears were purposely exposed to oil, both oiled bears immediately began grooming themselves in an attempt to clean their fur and suffered internal organ damage as a result of ingesting oil. One bear died of liver and kidney failure. The other bear was euthanized several weeks later and the subsequent necropsy revealed damage to liver, kidneys, and other organs (Oritsland et al., 1981). Bears are curious and will scavenge marine mammal carcasses when available. It is unclear whether polar bears would avoid petroleum hydrocarbon spills or contaminated carcasses. There is some evidence that bears actively will investigate petroleum products, such as cans of oil and neoprene fuel bladders (Stirling, as cited in Geraci and St. Aubin, 1990; Amstrup, 1989; Derocher and Stirling, 1991).

Due primarily to increased fall concentrations of bears on parts of the Beaufort Sea coast, the potential for a large oil spill to impact the SBS polar bear population on or near the coast has increased in recent years. Oil spills have a great potential for affecting polar bears in part due to the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. A large spill could impact large numbers of polar bears at coastal aggregations as well as in broken pack ice and lead systems offshore. Areas near Kaktovik, Cross Island, and Barter Island are particularly vulnerable. For example, 61 bears were observed on Bernard Spit near Barter Island in fall 2003 (Miller, Schliebe, and Proffitt, 2006). During winter and spring, when bears are less concentrated, the number of bears likely to be contaminated or indirectly affected as a result of a large oil spill on or near the coast would be smaller. Indirect effects to polar bears due to a spill include the possibility of local reductions in polar bear prey (ringed or bearded seals), displacement of bears or their prey due to cleanup efforts, and displacement from denning areas due to contamination or cleanup activities. The NRC has determined that a large spill (>1,000 bbl) in the Beaufort Sea would have major effects on polar bears and ringed seals (NRC, 2003b).

The Chukchi Sea population of polar bears is broadly distributed on the pack ice from the northern Bering Sea through the Chukchi Sea. Polar bears move south with the advancing pack ice in fall and winter, and north with the retreating ice edge in spring and summer. This leaves them particularly vulnerable to potential spills in the proposed lease sale area in spring and fall. Oil spills have a great potential for affecting polar bears in part due to the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. A large spill could impact large numbers of Chukchi Sea polar bears in broken pack ice and lead systems offshore, or at coastal aggregations on Wrangell Island, Herald Island, or along the Russian Chukotka coastline.

4.4.1.2.5. Potential Effects from Habitat Loss and Degradation.

Habitat loss due to changes in arctic sea ice has been identified as the primary cause of decline in polar bear populations. Declines in both the extant and persistence of sea ice are expected to continue throughout the polar bear's range for the foreseeable future and to lead to a further decline in the population (73 *FR* 28212-28303; DEIS, Section 3.2.4.3). The SBS and the CS populations of polar bears inhabit the Polar Basin Divergent Ecoregion. This ecoregion is characterized by ice forming and then being drawn away from the nearshore area by wind and current, particularly in summer (Amstrup, Marcot, and Douglas, 2007). The sea-ice decline is characterized by decreases in sea-ice extent and thickness and increases in the sea-ice retreat in spring and summer (see early summer sea ice, see DEIS, Figure 3.3.1-1). This decline is expected to have major impacts for the SBS and CS populations of polar bear. Amstrup, Marcot, and Douglas (2007) projected that these populations will be extirpated within the next 45-75 years, if sea ice declines continue at current rates.

Some coastal and nearshore habitat loss may occur from expansion of human activities in nearshore and coastal areas, or from coastal erosion due to increasing storm impacts along the coast. New facilities, causeways, harbor facilities, pipelines, or roads may cause loss of coastal habitat. For example, the proposed new airport and landfill at Kaktovik, and the proposed Endicott/Liberty expansion, both increase the human footprint in barrier island areas. Barrier islands in the Beaufort Sea have been identified as a preferred habitat of polar bears (Evans, 2008, pers. commun.). Temporary disturbances from the noise and traffic associated with building or expanding existing infrastructures would primarily be expected to occur during the open water season when barges and aircraft can more readily transport supplies. Theses activities may cause some temporary displacement from additional areas. Polar bears could be displaced in winter from preferred denning habitat in some instances, however, the footprint of completed structures is expected to be very small as compared to the overall habitat available.

4.4.1.2.6. Potential Effects from Seismic Noise.

Polar bears are closely tied to the presence of the sea-ice platform for the majority of their life functions, including hunting (Amstrup, 2003). Because effective seismic surveys are relegated to operating in an ice-free environment, 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 should be relatively short in duration and should have a negligible impact on polar bear populations.

Impacts to polar bears from marine open-water seismic activity have not been studied, but likely would be minor. Polar bears normally keep their heads above or at the water's surface when swimming, where underwater noise is weak or undetectable (Richardson et al., 1995a). 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. For bears that are already severely energetically stressed, however, this could prove fatal. 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). However, pregnant females and those with newborn cubs in maternity dens are sensitive to noise and vehicular traffic (Amstrup and Garner, 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. 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.

4.4.1.2.7. Potential Effects of Changes in the Physical Environment.

The status of polar bears worldwide is declining primarily as a result of climate change and the resultant loss of sea-ice habitat (73 *FR* 28212-28303). The recent release of the Arctic Climate Impact Assessment's report on *Impacts of a Warming Arctic* (ACIA, 2004), combined with a peer-reviewed analysis of the effects of climate change on polar bears by three of the world's foremost polar bear experts (Derocher, Lunn, and Stirling, 2004) indicate that polar bears are facing a cascading array of effects as a result of dramatic changes to their habitat. Observed changes to date include reduced sea-ice extent, particularly in summer, and progressively earlier sea-ice breakup dates, especially in more southerly areas.

Polar bear use of coastal areas during the fall open-water period has increased in recent years in the Beaufort Sea. This change in distribution has been correlated with the distance to the pack ice at that time of year (i.e., the farther from shore the leading edge of the pack ice is, the more bears are observed onshore) (Schliebe et al., 2005). The same correlation occurs in Chukotka, aggregations of CS polar bears and walruses on Wrangel Island, Herald Island, and along the coast are larger when the sea ice retreats farther offshore (Kochnev, 2005).

Projected impacts to polar bears from climate change would affect every aspect of the species' existence. The timing of ice formation and breakup will determine how long and how efficiently polar bears can hunt seals. Reductions in sea ice will result in increased distances between the ice edge and land which, in turn, will lead to increasing numbers of bears coming ashore during the open-water period, or drowning in the attempt. Reductions in sea ice also will also increase the polar bears' energetic costs of traveling, as moving through fragmented sea ice and open water is more energy intensive than walking across consolidated sea ice. Reductions in sea ice may result in reduced availability of ringed seals, and could result in direct mortalities of bears from starvation. Continued climate change also likely would increase the occurrence of bear-human interactions on land. All of these factors are likely to result in impacts to polar bear populations and distribution.

4.4.2. Mitigation Measures.

The mitigation measures are listed in Appendix 1.

4.4.3. Anticipated Direct and Indirect Effects from the Proposed Action

Definitions of adverse effects. Where there is a potential effect, the terms negligible, minor, moderate, and major are used to describe the *relative* degree or anticipated adverse effect on ESA-listed birds and the polar bear. Following each term below are the general characteristics we used to determine the anticipated level of adverse effect. The adverse level of effects are combined to determine the overall or net adverse effect level for the Proposed Action.

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. Unmitigatable 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. Unmitigatable 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. Unmitigatable or unavoidable adverse effects are widespread and long-lasting. Major effects most closely approach, but do not necessarily reach, "jeopardy" as defined by the ESA.

Polar Bears:
Negligible: Impacts include localized short-term disturbances or habitat effects that are not expected to continue across multiple seasons. For example, seismic surveys may occur for a few months each year, but do not occur year-round for multiple years. No mortality or impacts to reproductive success or

recruitment are anticipated. Mitigation measures are implemented fully and effectively or are not necessary.

Minor: Impacts include localized chronic disturbances; wide spread short term disturbances; and habitat effects that may persist over time, but are localized to a small area. No direct mortality is expected, though some short term impacts to a few individuals' reproductive success or to recruitment may occur. Mitigation measures are implemented when feasible, but some adverse effects are unavoidable. Unavoidable adverse effects are short-term and localized, for example, hazing an individual bear away from a work site.

Moderate: Impacts are widespread and may effect more than a few individuals, such as chronic disturbances at key locations or habitat effects that persist for multiple years. Direct mortality of a few individuals may occur; or direct mortality is not anticipated, but ongoing disruption to behavior patterns or important habitat may have high energetic or reproductive or recruitment costs that have the potential to negatively effect the population over time. A single event could result in moderate impacts depending upon the magnitude and specific characteristics of the event. Widespread implementation of mitigation measures for similar activities would likely be effective in reducing the level of unavoidable adverse effects. Unmitigable or unavoidable adverse effects are short-term but widespread; or are long term and localized.

Major: Impacts include widespread annual or chronic disturbance, habitat effects experienced during one season that would be anticipated to persist for decades, or widespread effects to reproductive success or recruitment. Anticipated or potential mortality could produce an immediate population-level effect. A single event could result in major impacts, depending upon the magnitude and specific characteristics of the event. Widespread implementation of mitigation measures could be effective in reducing the level of avoidable adverse effects. Unmitigable or unavoidable adverse effects are widespread and long-lasting. Major effects most closely approach, but do not necessarily reach, "jeopardy" as defined by the ESA.

4.4.3.1. Threatened and Endangered Birds

Summary: The loss of a small number of spectacled and Steller's eiders as a result of collisions with OCS-related structures from routine exploration activities could have a minor level of adverse effect on Steller's and spectacled eiders. Collisions are expected to have no effect on Kittlitz's murrelets or yellow-billed loons. Disturbance in or displacement from important habitats from exploration activities are anticipated to have a negligible level of effect on ESA-listed birds.

The following section describes the impact on ESA-listed birds resulting from the Proposed Action. The Proposed Action is to continue to authorize oil and gas exploration and development activities on the Alaskan Arctic OCS consistent with our previous leasing programs (Figure B) and those specified in our current 5-Year program. At this time industry holds leases on fewer than 500 lease blocks from a number of previous lease sales in the Chukchi Sea and fewer than 250 lease blocks from a number of 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). Our current program proposes additional lease sales in the Beaufort Sea and Chukchi Sea Planning Areas. Sales 209 and 217 in the Beaufort Sea would offer for lease the entire program area as scheduled in the 2007-2012 5-Year Program (Figure A).

4.4.3.1.1. Anticipated Effects from Vessel Presence and Noise. The Proposed Action could result in additional leases that could support the extension of oil and gas exploration activities (no more than six concurrent seismic surveys and no more than two drill structures) in the Beaufort Sea OCS over a new 10-year leasing period. These activities could extend the current potential effect a few years beyond the lease term of existing leases. A development project on the Beaufort Sea OCS could result in support vessel traffic over the production period. These activities could occur in areas where ESA-listed birds are not particularly abundant. As these potential effects are not expected to carry over from one year to the next, the effects do not accumulate and a longer duration would not increase the level of adverse effect.

The Proposed Action could also result in additional leases that could support the extension of oil and gas exploration activities (no more than six concurrent seismic surveys and no more than two drill structures) in the Chukchi Sea over a new 10-year leasing period. These activities could extend the current potential effect a few years beyond the lease term of existing leases. Mitigation measures imposed by MMS on existing and future exploration activities avoid or minimize adverse effects to ESA-listed birds in the Alaskan Arctic OCS. Development activities under the Proposed Action are not anticipated to occur in the Chukchi Sea.

Conclusion: Vessel activities under the Proposed Action are anticipated to result in a negligible level of effect on ESA-listed birds.

Exploration: Vessel activities associated with the Proposed Action are anticipated to result in limited disturbance to ESA-listed birds in the Beaufort Sea because there are few of these birds using nearshore areas there. Vessel activities in the Chukchi Sea are avoided or minimized by mitigation measures.

Development: Increased vessel traffic from a development in the Beaufort Sea could result in a negligible effect on ESA-listed birds because these species are present in low numbers and effects would not carry from one year to the next No development is anticipated in the Chukchi Sea.

4.4.3.1.2. Anticipated Effects from Aircraft Presence and Noise. The Proposed Action could result in additional leases that could support the extension of oil and gas exploration activities (no more than six concurrent seismic surveys and no more than two drill structures) in the Beaufort Sea OCS over a new 10-year leasing period. These activities could extend the current potential effect a few years beyond the lease term of existing leases. 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 km^2 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 km^2 (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.

Conclusion: Aircraft activities under the Proposed Action are anticipated to result in a negligible level of effect on ESA-listed birds.

Exploration: Aircraft activities associated with the Proposed Action are anticipated to result in limited disturbance to ESA-listed birds in the Beaufort Sea because there are few of these birds using nearshore areas there. Aircraft activities in the Chukchi Sea are avoided or minimized by mitigation measures.

Development: Increased aircraft traffic from a development in the Beaufort Sea could result in a negligible effect on ESA-listed birds because these species are present in low numbers and effects would not carry from one year to the next No development is anticipated in the Chukchi Sea.

4.4.3.1.3. Anticipated Effects from Collisions. Eiders typically migrate near the coast, flying fast and low over the ocean surface. Because this flight pattern can bring them into close proximity to structures before they can evade them (especially during periods of darkness or inclement weather), collisions occur and some eiders die. Murrelets and loons do not perform the same migration flight patterns and are not prone to collisions with structures.

Mitigation measures imposed on existing and future exploration and development activities are believed to minimize collision mortality to threatened eiders in the Alaskan Arctic OCS. At this time, however, the MMS cannot assume that recommendations for the design and implementation of lighting of structures would result in no strikes by threatened eiders. The MMS and FWS both acknowledge that estimating incidental take of listed eiders is extremely difficult due to a lack of available information. It is important to note that no threatened eider collisions have been documented to occur with OCS oil and gas facilities/structures and collision rates are based on a surrogate species, the common eider. There were a variety of assumptions made to support the calculations in the following sections and we have used the same variables in our estimated incidental take calculations as have been used for other recent agency consultations for purposes of consistency and comparison.

Exploration: Oil and gas 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, FWS, 2002). 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, 2003a). We consider this number to reflect estimated incidental take under the Proposed Action even though the period of effect could be extended for several years if any new leases are issued.

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. We consider this number to reflect estimated incidental take under the Proposed Action even though the period of effect could be extended for several years if any new leases are issued.

Development: Development and production from existing and future Beaufort Sea leases under the Proposed Action could occur and as many as 21 spectacled eiders (calculated as = 0.40 (spectacled eider strike rate) x 26 years (life of production) x 2 (maximum number of platforms)) and one Steller's eider (calculated as = 0.02 (Steller's eider strike rate) x 26 years (life of production) x 2 (maximum number of platforms)) would 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. The MMS would not authorize any development proposal that was determined to be likely to jeopardize the continued existence of an ESA-listed species.

Development and production from existing or future Chukchi Sea leases is speculative, and we 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 (USDOI, MMS 2006c). As the scenario remains unchanged, this number also would represent the collision impacts associated with a hypothetical development under the Proposed Action. As with the Beaufort Sea, further Section 7 consultation with FWS under the ESA would be required for any proposed development of Chukchi Sea OCS leases. The MMS would not authorize any development proposal that was determined to be likely to jeopardize the continued existence of an ESA-listed species.

Conclusion: The MMS considers incidental take from exploration and development under the Proposed Action to be an unavoidable, but minor level of adverse 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.

4.4.3.1.4. Anticipated Effects from Petroleum Spills. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect large numbers of ESA-listed birds because of their ability to spread and persist. Exposure of spectacled and Steller's eiders, Kittlitz's murrelets, and yellow-billed loons is expected to result in the general effects reviewed in Section 4.4.1.1.4. This analysis assumes that all birds contacted by oil would not survive and that secondary effects may cause impaired physiological function and production of fewer young. The mitigation measures described in Appendix 1 would be implemented for the Proposed Action. A large spill from a well blowout is described as a very unlikely event, and no large oil spills are assumed to occur during exploration activities (DEIS, Appendix A, Section 1.1.4).

It is important to remember that a large spill event associated with OCS oil and gas activities likely would occur only during the production phase, when volumes of oil or gas product is being moved to production facilities in the existing facilities at Kuparuk or Prudhoe Bay. Oil or gas production resulting from the Proposed Action is considered speculative and production effects are not considered reasonably foreseeable. Such a commercial discovery warranting production has not been identified or proposed for development and is considered speculative at this time. In other words, we acknowledge that a large spill could have a major level of effect on ESA-listed birds; however, a large spill from production activities is not considered a reasonably foreseeable future event.

The MMS models large spills to estimate the percent chance that a spill of certain size could contact important ERAs, and then analyzes the potential effects from oil spills to determine which resource areas might have the highest chance of contact. In the following sections, we evaluate the vulnerability of spectacled and Steller's eiders, Kittlitz's murrelets, and yellow-billed loons to oil spills (OSRA), then we describe the effect of disturbance from oil-cleanup activities, the effects of prey reduction or contamination, and the anticipated effects of that mortality on ESA-listed bird populations.

4.4.3.1.4.1. Vulnerability of ESA-Listed Birds to Oil Spills. Spectacled and Steller's eiders essentially are absent from the Beaufort Sea from late October to May and from the Chukchi Sea from late November to mid-April. Eiders returning to the breeding grounds in the 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, spending little, if any, time in the Beaufort Sea. Late-departing males and failed nesting females may head north to open waters of the Beaufort Sea as spring progresses and coastal ice has receded. A few satellite-tagged males were relocated in Simpson Lagoon and Harrison Bay (USDOI, MMS, 2003a: Figure 9b). In late August once all the chicks in a nest hatch, the hen moves the brood to coastal areas for rearing. An increasing number of female and juvenile eiders move to these nearshore areas as the brood-rearing season progresses. Once the chicks are flight capable, the 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).

Kittlitz's murrelets and yellow-billed loons similarly stage or forage in nearshore coastal waters unless they are incubating or brood-rearing at the nesting site. Use of the Chukchi Sea is much greater than the Beaufort Sea for both species.

4.4.3.1.4.2. Oil Spill Analysis.
We conducted an oil spill analysis for the Beaufort Sea (Section 4.1.1) and the Chukchi Sea (Section 4.1.2).

4.4.3.1.4.2.1. Oil Spill Analysis for the Beaufort Sea. The potential for spills to contact ESA-listed species in the Beaufort Sea was described in the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a). Due to small adjustments in the environmental resource area (ERA) polygons (size/shape), changes in lease areas, and other model refinements, we have updated the assessment for the proposed Beaufort Sea lease sales below. The results of this analysis are much the same as those for the previous lease sales in the Beaufort Sea.

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 of the project (DEIS, 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 (DEIS, Appendix A). The 1,500-bbl crude spill would cover a smaller area (181 km^2) (Table A.1-6) than a 4,600-bbl crude spill (320 km^2) (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 ERAs would be the same. Because of this similarity, the 4,600-bbl spill is analyzed.

A 4,600-bbl spill could contact ERAs where ESA-listed birds may be present (DEIS, 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 km^2. 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 km^2.

4.4.3.1.4.2.1.1. Conditional Probabilities. This section discusses the chance that a large oil spill from the Beaufort Sea lease-sale area could contact specific ERAs that are important to ESA-listed birds, assuming a large spill occurs.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting ESA-listed bird 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 DEIS Appendix A. Conditional probabilities assume a large spill occurs (see definition and applications, DEIS, Appendix A).

4.4.3.1.4.2.1.1.1. 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-listed eiders (DEIS, Tables A.1-13 and 14) from LAs within 30 days is <0.5-52% (DEIS, Table A.2-65) and <0.5-44% from PLs (DEIS, Table A.2-66), depending on the distance between the resource areas and the source of the spill (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% (DEIS, Tables A.2-89 and 90, 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 LAs and a <0.5-45% from PLs (DEIS, Tables A.2-69 and 70). The highest percent chance of contact is 54% to ERA2, Point Barrow and the Plover Islands, from a spill originating at LA2 (DEIS, Table A.2-69). The chance of contact to this ERA is highest, because the LA and the ERA are in close proximity to or overlap each other (DEIS, Maps A.1-2a and A.1-4). Other adjacent LAs 1-6 have 13-35% chance of contacting ERA2 within 180 days (DEIS, Table A.2-69). The highest percent chance of contact is to ERA68, Harrison Bay, which has a 45% chance of contact from PL9 within 180 days (DEIS, Table A.2-70). As with the LAs, the chance of contact to this ERA is highest because the PL and the ERA are in close proximity to or overlap each other (DEIS, Maps A.1-2a and A.1-4).

Spectacled and Steller's 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 (DEIS, Table A.2-69). Similarly, a spill originating from any pipeline segment would have <0.5% chance of contacting spectacled eiders using ERA19 within 180 days (DEIS, Table A.2-70).

Most post-breeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Area (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 Area during the May-October open-water period within 180 days (DEIS, Tables A.2-69 and 70).

4.4.3.1.4.2.1.1.2. 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 an LA and up to a 32% chance from a PL will contact ERAs important to ESA-listed birds within 180 days (DEIS, Table A.2-117 and A.2-118). 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 (DEIS, Table A.2-117). 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 (DEIS, Table A.2-117 and A.2-118).

Most post-breeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Area (ERA 10). A large spill originating from any LA or PL would have a <0.5% chance of contacting the Critical Habitat Area within 180 days, melting out in spring (DEIS, Tables A.2-17 and 118). 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 Area (ERA10), within 180 days (DEIS, Appendix A, Table A.2-21).

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.

4.4.3.1.4.2.1.2. Combined Probabilities. Combined probabilities differ from conditional probabilities in that they do not assume that a spill has occurred and consolidate non-uniform weighting of launch probabilities into one unit probability. The risk that a large spill would occur is multiplied by the area-wide probability that spilled oil would reach a particular ERA to calculate a combined probability that both would occur simultaneously. Combined probabilities are defined in Appendix A (Section 4.3) of the DEIS. The combined probabilities for a large spill occurring and reaching ERAs of most concern to threatened bird species are in Table 4.4.2.6.2-2 of the DEIS. These probabilities are broken into different periods to indicate volatility, weathering, and movement of the spill over time.

4.4.3.1.4.2.2. Oil Spill Analysis for the Chukchi Sea. The potential for spills to contact ESA-listed species in the Chukchi Sea was previously described in the Chukchi Sea Lease Sale 193 final EIS (USDOI, MMS 2007d). 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 lease sales below. The results of this analysis are much the same as those for the previous lease sale 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 a spill occurring over the life of the project (Appendix A, Table A.1-28). For the development and production phases, 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 km^2) (Appendix A, Table A.1-11) than a 4,600-bbl spill (1,008 km^2) (Appendix A, 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 ERAs where ESA-listed birds may be present (DEIS, 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 km^2. 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 km^2.

4.4.3.1.4.2.2.1. Conditional Probabilities. This section discusses the chance that a large oil spill from the Chukchi Sea lease sale area could contact specific ERAs that are important to ESA-listed birds, assuming a hypothetical large spill occurs.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting ESA-listed bird 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. DEIS, Table A.1-14 show ERAs and Maps A.1-2a-e show their spatial locations. Conditional probabilities are based on the assumption that a large spill occurred (see definition and applications, DEIS, Appendix A).

4.4.3.1.4.2.2.1.1. 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 launch areas will contact ERAs important to ESA-listed birds within 180 days, and a <0.5-56% chance from a pipeline (DEIS, Table A.3-35). 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 ERA are in close proximity to or overlap each other (maps, DEIS, 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 ERA are in close proximity to or overlap each other.

Spectacled and Steller's 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 (DEIS, Table A.3-35). Similarly, a spill originating from PLs 6, 9, or 11 has a 12-14% chance of contacting ERA19 within 180 days (DEIS, Table A.3-35).

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

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.

4.4.3.1.4.2.2.1.2. 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 a launch area contacts ERAs important to ESA-listed birds within 180 days, and a <0.5-35% from a pipeline (DEIS, Table A.3-59 and maps). 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 ERA in the OSRA model are in close proximity to or overlap each other (DEIS, Table A.3-59 and maps).

Most post-breeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Area (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 (DEIS, Table A.3-5).

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.

4.4.3.1.4.2.2.2. Combined Probabilities. Combined probabilities differ from conditional probabilities in that they do not assume that a 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 area-wide probability that spilled oil would reach a particular ERA to estimate a combined probability that both would occur simultaneously. Combined probabilities are defined in Appendix A (Section 4.3) of the DEIS. The combined probabilities of one or more large spills occurring and reaching ERAs of most concern to ESA-listed bird species are in Table 4.5.2.6.2-1 of the DEIS. These probabilities are broken into different periods to indicate volatility, weathering, and movement of the spill over time.

If the chance of 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; DEIS, Maps A.1-2a through e) within 30 days is ≤1% over the 20-year production life of the Proposed Action (DEIS, 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.

4.4.3.1.4.3. Chronic Small Spills. Small or low-volume spills are defined as being <1,000 bbl. The average crude-oil spill size is 126 gal (3 bbl) for spills <500 bbl.

<u>Beaufort Sea:</u> An estimated 89 small crude oil spills could occur during the 20-year oil production period, an average of more than 4 per year (DEIS, 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 (DEIS, 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.

<u>Chukchi Sea:</u> An estimated 178 small crude oil spills would occur during the 25-year oil production period (DEIS, 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 (DEIS, Table A.1-32), an average of 17.6 per year. Overall, an estimated 25 small-volume oil spills would occur each of the 25 years of production.

It is unknown how many small-volume spills or what total volume would reach areas used by ESA-listed birds. If these low-volume spills were in close proximity to or within the Ledyard Bay Critical Habitat Area, a large number of molting spectacled eiders could be contacted and injured or killed. Kittlitz's murrelets, yellow-billed loons, 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.

4.4.3.1.4.4. 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. During 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 ESA-listed birds.

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).

4.4.3.1.4.5. 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. 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 USDOI, MMS, 2002: Section III.C.2.c).

4.4.3.1.4.6. Anticipated Mortality from an Oil Spill.

<u>Beaufort Sea:</u> 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 could be exposed to oil from a 5,912-bbl spill. This would represent

0.003% of the estimated population 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 enroute 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 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 USDOI, MMS, 2002: Section III.C.2.a(2)).

<u>Chukchi Sea:</u> 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 et al. (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 to the coast and then head 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 Area (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 a substantial part of the breeding female spectacled eiders of the Arctic Coastal Plain could 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 enroute to the breeding grounds. A spill of this magnitude could 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.

4.4.3.1.4.7. Conclusion, Spill Effects

<u>Beaufort Sea</u>**:** To put the risk of a large spill having population-level effects in perspective, one has to consider several variables. First, to ever have a large oil spill, production would have to occur. The most likely scenario states the optimistic probability of a successful commercial find in the Beaufort Sea was 20%. We calculated the probability of a successful development by multiplying the probability of success per sale by the number of lease sales considered (80% failure rate x 5 sales = 33%). If the overall failure rate is 33%, the chance of a development success for the Proposed Action is calculated to be (100% – 33% =) 67%, indicating that development and production could occur. This finding is different than the conclusion in the Multiple-Sale DEIS because this analysis considers historic sales with undeveloped leases, thus the Proposed Action evaluated in this assessment is not the same Proposed Action evaluated under the NEPA EIS process.

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 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 an ERA important to murrelets, yellow-billed loons, 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 generally 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 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, the MMS must complete Section 7 consultation with the FWS on a production plan. As with the Sale 193 final EIS (see Information to Lessees, Appendix F of the Arctic Multiple-Sale DEIS), a future project would not be authorized by MMS if it was likely to result in jeopardy or adverse modification of designated critical habitat as determined by FWS. The MMS 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-listed species.

Chronic, low-level 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 spill coupled with a variety of other factors that would need to be satisfied to result in mortality, MMS 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 to ESA-listed birds is anticipated.

Chukchi Sea**:** An oil spill contacting the Ledyard Bay Critical Habitat Area (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 a substantial 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 a large oil spill, production would have to occur. The most likely scenario states the probability of a successful commercial find is <10% per sale, indicating that production is unlikely (USDOI, MMS, 2007c). We calculated the probability of a successful development by multiplying the probability of success per sale by the number of lease sales considered (90% failure rate x 3 sales = 73%). If the overall failure rate is 73%, the chance of a development success for the Proposed Action is calculated to be (100% – 73% =) 27%, indicating that development and production from the three sales is unlikely. This finding is consistent with the conclusion in the Multiple-Sale DEIS and even though this analysis considered undeveloped leases from Lease Sale 193, the Proposed Action evaluated in this assessment is similar to the Proposed Action evaluated under the NEPA EIS process.

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 spill contacting the spring lead system could affect a relatively large proportion of the Steller's eider population staging enroute 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, MMS must complete Section 7 consultation with FWS on a production plan. As with the Lease Sale 193 final EIS (see Information to Lessees, Appendix F of the Arctic Multiple-Sale DEIS), "…a future project would not be authorized by MMS if it results in jeopardy or adverse modification of designated critical habitat as determined by FWS." The MMS 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-listed species in the Chukchi Sea.

Chronic low-level 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 spill coupled with a variety of other factors that would need to be satisfied to result in mortality, MMS 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.

4.4.3.1.5. Anticipated Effects from Increased Bird Predator Populations. There would not be any change in bird predator populations due to exploration activities included in the Proposed Action.

Increased predator populations resulting from the Proposed Action would only arise from the construction of development and production facilities, which are only calculated to occur in the Beaufort Sea OCS. If production is ever proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to ESA-listed birds. 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 and is anticipated to be implemented for any future developments associated with Federal leases. Implementation and enforcement of a leasing stipulation could be expected to minimize any effects of increased predator populations resulting from Federal actions in the OCS.

Conclusion: The Proposed Action would have no effect on bird predator populations in the Alaskan Arctic.

4.4.3.1.6. Anticipated Effects from Subsistence Hunting Activity. There would not be any change in subsistence hunting effects on ESA-listed birds related to OCS exploration activities in the Beaufort or Chukchi seas.

Increased subsistence-hunting activity could arise only from the construction of development and production facilities. Using scenario-based probabilities for the Proposed Action, development is could occur in the Beaufort Sea but is not anticipated to occur in the Chukchi Sea. There could be an incremental increase in the total number of gravel roads that could be used by bird hunters if a Beaufort Sea development occurs. For example, we assume that a pipeline would carry products to pre-existing infrastructure for transport to processing facilities. The pipeline 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 accidental or illegal harvest of spectacled or Steller's eiders.

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 74% were shot. 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).

Attention to this problem, educational programs, enforcement of existing or new changes to hunting laws could all minimize the illegal killing of Steller's (and spectacled) eiders. The long-term consequences of a proposed OCS development would be evaluated in future NEPA documents and via formal consultation under the ESA. Such site-specific information would allow a more detailed assessment of potential changes in subsistence hunting at that time.

Conclusion: Exploration activities associated with existing and future OCS leases are anticipated to have no effect on ESA-listed birds.

Development: A development from leases in the Beaufort Sea OCS could contribute towards increased subsistence hunter access. Depending on the location of future facilities, there is some potential for illegal shooting of ESA-listed birds from additional access points, but the amount of this mortality is very difficult to predict. Shooting mortality may not be an issue in if education and enforcement efforts prove to be successful. No developments on the Chukchi Sea OCS are anticipated.

4.4.3.1.7. Anticipated Effects from Habitat Loss.

Exploration: There would not be any permanent loss or alteration of bird habitat during exploration and delineation activities. Small amounts of temporary habitat loss of Steller's and spectacled eider migration habitats could occur from drilling exploration or delineation wells into the seafloor. Benthic habitats in used by birds could be temporarily disturbed and/or altered by drilling exploratory or delineation wells in the seafloor. These well-site areas would be small and would be expected to return to pre-drill condition in <3 years.

Development and Production: Permanent habitat loss would only arise from the construction of development and productions facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure), which is probable in the Beaufort Sea, but is not anticipated in the Chukchi Sea. Indirect habitat losses could result from eiders, murrelets, and yellow-billed loons not using habitats near sites of industrial activity. If production is ever 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 or degraded, nesting habitat has not been identified as a factor limiting eider populations. Also, future filling of wetlands would be subject to U.S. Army Corps of Engineers permitting processes and a subsequent Section 7 consultation under the ESA.

Hypothetical Beaufort Sea Development Habitat Effects: Direct impacts to spectacled and Steller's eider nesting habitats could arise from the facility footprints. The MMS 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 (DEIS, Table 4.4.1.6.2-1). Onshore developments could originate at a pipeline landfall, the location of which is unknown. The pipeline and associated developments conceivably would then be the shortest, most cost-effective route to connect with pre-existing support infrastructure.

As a pipeline is expected to be placed on elevated structures or, less frequently, buried near, but not immediately adjacent to, the 19.8-m-wide (65-ft-wide) road, the pipeline "footprint" was integrated with the road footprint into a 0.03 km-wide (100-ft-wide) road/pipeline development "corridor." The road and pipeline corridor was assumed to be 80 km (50 mi) long. Consequently, direct impacts from pipeline and road construction are estimated to affect 2.45 km^2 (606 acres) of eider nesting habitat (Table 4.4.1.6.2-1). The shore base and staging facilities were assumed to each have gravel footprints of 0.2 km^2 (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 km^2 (40 acres). The construction of an additional airstrip, if needed, is estimated to have a footprint of 0.04 km^2 (10 ac). 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 USDOI, BLM and MMS, 2003, presently undeveloped) or existing gravel pits would be used or expanded for material to construct the development facilities. For purposes of analysis, we estimated that 0.40 km^2 of eider nesting habitat would be affected by gravel extraction. Overall, these developments are estimated to have a footprint of 3.45 km^2 (855 acres) in eider nesting habitats, resulting in an estimated take of four spectacled eiders and one Steller's eider (DEIS, Table 4.4.1.6.2-1). No critical habitat for ESA-listed birds has been designated in the Beaufort Sea.

Indirect Habitat Losses. Temporary and indirect habitat loss via displacement during construction and operation could occur if production facilities (offshore platform, an undersea pipeline) are located in areas used by Steller's and spectacled eiders and 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 could arise from terrestrial habitat modifications (drainage, flooding, dust impacts to vegetation, changes in thermokarst) and disturbances from traffic and human activities. The rational 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. Overall, these zones of influence associated with development facilities have a collective areal extent of 33 km^2 (8,522 acres) in eider nesting habitats, resulting in an estimated indirect take of 37 spectacled eiders and two Steller's eiders (DEIS, Table 4.4.1.6.2-1).

Many long-term disturbing activities could have fewer impacts to ESA-listed birds if they were to occur during winter, when these birds are not present. Material-extraction activities were assumed to occur during winter, when eiders would not be present, and a secondary zone of influence from these areas was considered not applicable.

Overall, developments in the Beaufort Sea are estimated to have a direct footprint of 3.45 km^2 (855 ac) 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 38 km^2 (9,378 ac) in eider nesting habitats, resulting in an estimated indirect take of 42 spectacled eiders and 3 Steller's eiders (DEIS, Table 4.4.1.6.2-1).

These projects would require Section 7 consultation with the FWS. As with the Lease Sale 193 final EIS (see Information to Lessees, Section 4.5.1.6.2.3.2.4 of the DEIS), MMS 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. The MMS 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-listed species in the Beaufort Sea.

<u>Hypothetical Chukchi Sea Development Habitat Effects:</u>
The MMS 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, 2007d) and remains the same for the Proposed Action (DEIS, Table 4.5.1.6.2-1):

> As a pipeline is expected to be placed on elevated structures or, less frequently, buried near, but not immediately adjacent to, the 19.8-meter-wide (65-foot-wide) road, the pipeline "footprint" was integrated with the road footprint into a 0.03 km-wide (100-foot-wide) road/pipeline development "corridor". The road/pipeline corridor was assumed to be 482.8 km (300 miles) long. Consequently, direct impacts from pipeline/road construction are estimated to affect 14.72 km^2 (3,636 ac) of eider nesting habitat.

The shore base and staging facilities were assumed to each have gravel footprints of 0.2 km^2 (50 ac) 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 km^2 (395 ac 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 to construct the development facilities. For the purposes of analysis, we estimated that 1.60 km^2 of eider nesting habitat would be affected by gravel extraction.

Overall, these developments could have a footprint of 17.37 km^2 (4,291 ac) in eider nesting habitats, resulting in an estimated indirect take of 19 spectacled eiders and one Steller's eider.

Indirect Habitat Losses. Temporary and indirect habitat loss via displacement during construction and operation could occur if production facilities (offshore platform, an undersea pipeline) are located in areas used by Steller's and spectacled eiders and candidate species. Indirect habitat losses could result from eiders, murrelets, and loons not using habitats near sites of industrial activity. Drilling offshore exploration wells could result in a temporary loss (via displacement) of spectacled eider habitat. A production platform, if located within the Ledyard Bay Critical Habitat Area, could have multi-decadal displacement effects on eiders and other birds using this area.

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 decided to adopt the methodology used by recent similar projects for NPR-A (BLM 2003, FWS 2005). The rational 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 (DEIS, Table 4.5.1.6.2-1).

Many long-term disturbing activities could have fewer impacts to spectacled and Steller's eiders if they were to occur during the winter, when eiders are not present. Material extraction activities were assumed to occur during the winter, when eiders would not be present, and a secondary zone of influence from these areas was considered not applicable.

Overall, these zones of influence associated with development facilities developments have a collective areal extent of 196.13 km^2 (48,464 ac) in eider nesting habitats, resulting in an estimated direct take of 216 spectacled eiders and 12 Steller's eider.

These projects would require Section 7 consultation with the FWS. As with the Lease Sale 193 final EIS (see Information to Lessees, Section 4.5.1.6.2.3.2.4 of the DEIS), MMS 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. The MMS 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-listed species in the Chukchi Sea.

Conclusion:
Exploration: Offshore exploration and delineation drilling activities associated with the Proposed Action are anticipated to result in a negligible level of adverse effect on ESA-listed birds.

Development: Any future development and production plans would require Section 7 consultation with the FWS. As with the Lease Sale 193 (see Information to Lessees, Section 4.5.1.6.2.3.2.4 of the DEIS), MMS 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. The MMS believes that this condition will help industry incorporate stringent spill-prevention and other measures into their plans that avoid the risk of population-level effects on ESA-listed species in the Alaskan Arctic. In many cases, mitigation measures that benefit threatened eiders also benefit candidate bird species.

4.4.3.1.8. Anticipated Effects from Seismic Airgun Noise. Seismic activities are used to locate and delineate potential oil and gas resources and help guide siting of offshore facilities. Most seismic activity on land or ice is done during winter, when ESA-listed birds are absent.

Seismic work, exploratory/delineation drilling, 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. The MMS analyzed the effects of no more than six concurrent seismic surveys and/or no more than two active drilling operations in each sea. Depending on the location of the drill site, MMS will impose mitigation measures on future exploration drilling activities to avoid or minimize adverse effects to ESA-listed birds in the Alaskan Arctic OCS.

Conclusion.
Seismic surveys during exploration activities under the Proposed Action is anticipated to result in a negligible effect on ESA-listed birds in the action area.

Seismic activities associated with ancillary activities related to a potential OCS development in the Beaufort Sea are anticipated to have a negligible level of effect on ESA-listed birds. No developments are anticipated in the Chukchi Sea under the Proposed Action.

4.4.3.1.9. Anticipated Effects from Changes in the Physical Environment. Changes in the physical environment are believed to result from climate changes superimposed on the vagaries of regional weather patterns. Section 4.4.1.1.9 briefly described likely ongoing effects from changes in oceanographic processes and sea-ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise. These changes in the physical environment may affect marine and coastal bird populations, including ESA-listed birds.

Some of these expected changes could benefit coastal birds using habitats on the ACP, at least initially. Expansion of more productive wetland habitats could provide additional nesting sites for several species and boost the abundance and distribution of aquatic plants, insects, and fish important to many bird species. These benefits to birds would be expected to decline over time as the wetlands and lakes disappear. Climatic change could have stochastic or habitat effects on many species that may surpass the impacts of other activities; however, the implications of climate change on coastal and marine birds are impossible to predict with any precision. For purposes of analysis, we assume most of the obvious trends are anticipated to continue. We considered these trends in determining the effects of the Proposed Action; however we concluded that these long-term trends are outside the influence of the Proposed Action and the Proposed Action is anticipated to have no effect on greenhouse gas emissions.

The MMS considered environmental impacts associated with the Proposed Action when there is a reasonably close causal relationship between the environmental effect and the alleged cause. MMS drew a manageable line between the impacts associated with exploring for/producing oil and gas and the impacts associated with consuming them. The USDOI has the authority to regulate the location and manner of resource production; therefore, it is appropriate to attribute production-related impacts to the Agency's authorizing "action." Because the USDOI lacks any direct authority to promote or reduce *consumption* of commodity oil and gas, it is not appropriate to consider the endless cascade of environmental impacts that might flow from such consumption. Those impacts are more properly attributed to market demand and other government actions more directly concerned with managing or controlling demand.

The argument that potential sources of energy that could be generated from Alaskan Arctic OCS oil or gas development contributes to further changes in the physical environment fails to recognize that America has large energy needs and energy not produced from the Alaska OCS would likely continue to be replaced by foreign imports. Overall, as America uses these fuels, it affects worldwide CO_2 levels and climate change to the same extent, regardless of their source.

Conclusion: The Proposed Action does not have a direct cause-effect relationship on climate change and no effect on ESA-listed birds is anticipated.

4.4.3.2. Polar Bear.

Summary. This analysis describes the anticipated effects of implementing the Proposed Action on the polar bear. The Proposed Action is to continue to authorize oil and gas exploration and development activities on the Alaskan Arctic OCS consistent with our previous leasing programs (Figure B) and those specified in our current 5-Year program. At this time industry holds leases on fewer than 500 lease blocks from a previous lease sale in the Chukchi Sea and fewer than 250 lease blocks from a number of previous lease sales in the Beaufort Sea (Table A and Figure A). Of these, three blocks in the Beaufort Sea are producing oil (BP Alaska Inc's Northstar project), and two blocks are in development (BP Alaska Inc.'s Liberty project). Our current program proposes additional lease sales in the Beaufort Sea and Chukchi Sea Planning Areas.

Exploration Activities: The temporary displacement of a few polar bears from preferred foraging habitats is anticipated as a result of routine on ice exploration activities. Chronic disturbance or displacement can have moderate effects over time, but is not anticipated. Mitigation measures currently in place on the North Slope have proven to be very effective at avoiding disturbance to denning bears.

Mitigation measures currently in place are expected to continue to moderate potential effects to polar bears. Mitigation measures may include locating den sites using FLIR flights, and avoiding den areas by a prescribed distance, hazing bears away from ongoing activities, avoiding open lead systems where polar bears hunt for seals, and managing camp and work areas so that they do not become bear attractants. Mitigation measures for the Proposed Action are described in detail in Appendix 1. Additional mitigation may be determined on a case by case basis as a part of the LOA process during consultation with FWS. Disturbance in or displacement from important habitats during exploration activities are anticipated to be short term temporary effects and to have negligible or minor effects on the fitness or survival of individual bears (DEIS, Tables 4.4.2.6.3-1 and 4.4.2.6.3-2) and to have no adverse effects on the polar bear population. Indirect effects to polar bears could include effects to ringed seals, polar bears' principle prey species. To date, the oil and gas industry on the North Slope has not been shown to have adverse impacts to ringed seal populations or distribution and no indirect effects to polar bears are anticipated.

Development Activities: Development and production activities could result from existing or new OCS leases, although production would not take place unless another commercially viable discovery is made.

Effects from a production project are analyzed to determine the anticipated effects on the polar bear population, if such a discovery is made and proposed for development in the more distant future. Additional analysis would take place if and when a development and production plan for a specific site is submitted. Site specific mitigation could be determined and implemented at that time. The plan would not be approved if it were determined that implementation of the plan would lead to a jeopardy determination for the polar bear under the ESA.

The primary impacts to polar bears from production-related activities include habitat losses due to construction of development/production facilities, pipelines and the associated infrastructure; and the potential for oil spills. Potential habitat losses on barrier islands and along the coast could displace polar bears from denning areas that appear to be increasing in importance. Barrier islands and coastline occur in State leasing areas, while OCS lease sale areas begin 3 miles offshore. Fischbach, Amstrup, and Douglas (2007) reported that more dens are being located onshore than on sea ice in the Beaufort Sea (a shift from 40% to 60% of dens located onshore). Smirnoff et al. has reported increases in numbers of polar bears onshore on the Russian Arctic coast and also reports large aggregations of bears at walrus haulouts and near beached whale carcasses (Smirnoff, unpublished report 1983). Long-term displacement from preferred denning and feeding habitats could have adverse effects and result in a major impact to the polar bear population. Direct mortality of polar bears from production activities, including habitat loss and hypothetical spills, are not expected, but could represent a major level of effect, if they were to occur. Most displacement of polar bears is expected to be temporary and to have only negligible or minor effects on individual bears. The Proposed Action is not anticipated to have an adverse effect on the polar bear population.

This section describes the anticipated effects to polar bears resulting from implementing the Proposed Action. Mitigation measures are briefly described in Appendix 1. Important factors that are considered in determining the anticipated effects from the Proposed Action include timing, spatial extent, and the effects of oil spills.

4.4.3.2.1. Anticipated Effects from Vessel Presence and Noise. The Proposed Action could result in a limited spatial or temporal expansion of existing levels of seismic exploration and support vessel activities in the Alaskan Arctic OCS (compared to 2006, 2007, and 2008). More icebreaker traffic, particularly in the lead system could increase the level of temporary displacement or disturbance to polar bears associated with exploration activities. Most OCS exploration operations are offshore in open water and seldom come into contact with polar bears. Mitigation measures required on vessel-based activities avoid or minimize adverse effects to polar bears by requiring operators to have marine mammal observers on board and avoid displacing marine mammals by changing course or speed, or avoiding some areas altogether. Seismic vessels are required to shut down operations if polar bears come within the 190dB range. Currently, OCS activities in the Chukchi Sea are limited to exploration by seismic vessels and associated support or research vessels, and to transit through the Chukchi Sea on the way to OCS operations in the Beaufort Sea. OCS-related vessel activities are currently restricted within the spring lead systems through the LOA/ IHA process, and operations may not begin in the Chukchi Sea until after July 1. This mitigation measure is designed to avoid conflicts between vessels and marine mammals in the spring lead systems. No more than six seismic operations may operate in OCS waters of the Beaufort and Chukchi seas at any one time due to stipulations of the Arctic Region Biological Opinion issued by the National Marine Fisheries Service.

Conclusion: Incremental increases in vessel traffic from OCS activities are expected to have negligible impacts to polar bears and will not adversely impact the polar bear population.

4.4.3.2.2. Anticipated Effects from Motorized Vehicle Presence and Noise. An incremental increase in motorized traffic related to exploration activities is expected due to the Proposed Action. Exploration activities may include building ice roads, temporary ice islands as drilling platforms, helicopter flights to move crews and lightweight equipment, rollogons, snowmachines, vibrosis equipment and other motorized vehicle use. The level of impact related to these activities will depend upon the timing and extent of activities occurring simultaneously. Noise from motorized vehicles and aircraft traffic could impact polar bears by: (1) displacing bears from preferred habitats during denning; (2) displacing bears from preferred foraging habitats; (3) reducing foraging efficiency and feeding time; (4) causing bears to abandon dens prematurely; (5) disrupting movements onshore and offshore; and (6) causing heat stress and/or unnecessary energetic expenditures. Denning bears could be disturbed, for example by repeated traffic and noise during the fall and winter season. If female bears and cubs are forced prematurely from their dens, this could impact the survivorship of the young. Individual tolerance to disturbance varies greatly and some polar bears may tolerate noise and activity in close proximity while others will not.

Beaufort Sea:
The Proposed Action could result in a continuation or limited expansion of existing levels of aircraft and other motorized activity in the Beaufort Sea (compared to 2006, 2007, and 2008).

<u>Exploration:</u> Ongoing and future exploration activities under the Proposed Action could result in an incremental increase in aircraft traffic as a part of support for offshore operations (marine mammal surveys and crew change outs). We anticipate that aircraft associated with OCS exploration activities will be from coastal bases to offshore operations, or marine mammal surveys. These flights would remain 1,500 ft AGL or higher (as safety concerns allow) and will avoid aggregations of marine mammals and polar bear dens. Impacts to polar bears from over flights are anticipated to be limited to short term temporary disturbances. Impacts from this increased traffic would be minor.

On-ice seismic surveys along the Beaufort Sea coast have the potential to displace foraging polar bears or to disturb bears in dens. However, mitigation measures imposed on oil and gas exploration and development activities through the LOA process avoid or minimize adverse effects to polar bears in the Beaufort Sea by requiring that den searches be conducted before the onset of any terrestrial or nearshore work, requiring that vehicles operated by the O&G industry avoid known dens by prescribed distances, requiring that polar bear monitors be on hand to haze polar bears away from humans before encounters rise to the level of lethal take, and requiring that workers remain in or at their vehicles unless actively working with security or bear patrol personnel. These standard mitigation measures have proven to be very effective at reducing impacts to polar bears to negligible levels.

<u>Development:</u> Our Beaufort Sea development scenario assumes the discovery and subsequent development of new fields. The most likely result is a discovery of two or three co-located fields totaling 500 MMbbl (Figure D-3 of the DEIS). Such a discovery could potentially result in a drilling platform, one or more pipelines to shore, one new shorefall, and a land base. An increase in motorized traffic and noise would occur during construction, and would decrease once facilities were in place. Given the scenario, we expect that although some displacement and disturbance of polar bears may occur, most displacement would be temporary and localized and effects to polar bears are expected to be minor and are not likely to adversely affect the polar bear.

Chukchi Sea:
The Proposed Action could result in a continuation or limited expansion of existing levels of aircraft and other motorized activity in the Chukchi Sea (compared to 2006, 2007, and 2008).

<u>Exploration:</u> Ongoing and future exploration activities under the Proposed Action could result in an incremental increase in aircraft traffic as a part of support for offshore operations (marine mammal surveys and crew change outs). We anticipate that aircraft associated with OCS exploration activities will be from coastal bases to offshore operations, or marine mammal surveys. These flights would remain

1,500 ft AGL or higher (as safety concerns allow) and will avoid aggregations of marine mammals and polar bear dens. Impacts to polar bears from over flights are anticipated to be limited to short term temporary disturbances. Impacts from this increased traffic would be negligible or minor. Increases in shore-based traffic, such as rollogons, snowmachines and other tracked vehicles are not anticipated in the Chukchi Sea. On-ice seismic operations are not anticipated because the bathymetry and formation of shore ice along the Chukchi coast does not facilitate these activities. No increase in impacts from shore-based vehicles are anticipated at the exploration stage.

<u>Development:</u> If exploration activities lead to development of production facilities at a later date, shore based facilities will be developed, including roads, pipelines, and presumably a camp infrastructure. This may lead to an increase in motorized vehicle traffic onshore, particularly during construction. OCS operators will be required to follow mitigation procedures similar to those currently in place in the Beaufort Sea. At this time we have no information to indicate where an oil field may be developed or where the closest shore base would be located, but this would presumably increase traffic in that area. The level of impact would depend upon the size and location of road ways or access points. Given the history of similar development on the North Slope with only minor impacts to polar bears, MMS anticipates that motorized traffic properly mitigated would have negligible impacts to polar bears.

Conclusion: Impacts to polar bears from increased air and terrestrial vehicle traffic during exploration and development activities in the Beaufort and Chukchi seas are expected to be minor. Standard mitigation measures currently in place, which include avoiding known denning areas and minimizing disturbance of foraging bears, are expected to continue to be applied.

4.4.3.2.3. Anticipated Effects from Subsistence and Other Harvests.

Summary. Mitigation measures currently in place throughout the North Slope have been very successful in reducing human-bear interactions in relation to oil and gas industry activities and decrease the likelihood of polar bear in defense of human life takes. These measures apply to existing leases and are expected to be applied to any future OCS leases. We expect these mitigation measures to continue to be effective. Polar bears may occasionally be hazed away from industry operations (platforms or industrial camps) to eliminate the potential risk to humans or bears. The Proposed Action is expected to have negligible impacts on subsistence or other harvest of polar bears. For more information on impacts to subsistence, see Section 4.5.2.12 of the DEIS.

Beaufort Sea: We anticipate that subsistence take of the SBS (Beaufort Sea) polar bear population will continue to be managed cooperatively through the Inuvialuit-Inupiat Polar Bear Management Agreement, and that harvest will continue at rates below the maximum sustainable yield. We anticipate that subsistence take will continue to result in the direct mortality of a few individuals, and as such will have a moderate impact on polar bears. Any increase in the numbers of polar bears remaining onshore near human habitation, or an increase in the duration of time that polar bears spend onshore, may lead to an increase in take in defense of human life. We do not anticipate that exploration or development activities on the OCS will impact the subsistence take of polar bear. Mitigation measures currently in place have been very effective at reducing the take of polar bears in association with industry activities to the level of occasional disturbance events (primarily hazing).

Chukchi Sea: We anticipate that subsistence take in Alaska of the CS (Chukchi Sea) polar bear population will continue to be very small. Overharvest of the CS population of polar bears is due primarily to illegal take occurring in Russia and may continue for the foreseeable future. Any increase in the numbers of polar bears remaining onshore near human habitation, or in the duration of time that polar bears spend onshore, may make them more vulnerable to poaching and to an increase in take in defense of human life. We do not anticipate that exploration or development activities on the OCS will impact the subsistence take of polar bear. Mitigation measures currently in place have been very effective at reducing the take of polar bears in association with industry activities to the level of occasional disturbance events (primarily hazing).

Conclusion: Current mitigation measures have proven effective and we anticipate that this will continue to be the case. Exploration and development activities on the OCS in the Beaufort and Chukchi seas are not anticipated to have more than a negligible or minor effect on the take of polar bears.

4.4.3.2.4. Anticipated Effects of Petroleum Spills.
Summary. A large spill from a well blowout is described as a very unlikely event, and we assume that no large oil spills will occur during exploration activities. A potential spill from OCS activities, if one were to occur, would be associated with future development and production. If a large spill were to occur in an area where polar bears were concentrated by food resources, such a spill could result in a loss of as many as 60 bears. However, the likelihood of a large spill occurring from OCS activities is very small, and the potential that it would occur near an aggregation of polar bears temporally and spatially is even smaller. We anticipate that small spills that occur as a result of the Proposed Action will not differ from small spills occurring on the North Slope as a result of previous lease sales. Small spills are expected to have negligible impacts to polar bears and are not likely to adversely affect the polar bear.

Beaufort Sea: The potential for large spills to contact polar bear habitats in the Beaufort Sea was analyzed in the Beaufort Sea multiple-sale (sales 186, 195, 202) final EIS (USDOI, MMS 2003a). This analysis was again updated in the EA for Lease Sale 202 (USDOI, MMS 2006b). We have updated the assessment for lease sales 209 and 217. The results of this analysis are similar to past analyses. Spills in the marine environment that occur during the late summer or fall near barrier islands where aggregations of polar bear occur have the greatest potential to affect polar bears. However, based upon OSRA runs, the probability of a spill contacting these barrier islands in the Beaufort Sea is <5%, if such a spill were to occur.

Chukchi Sea: The potential for spills to contact polar bear habitats in the Chukchi Sea was analyzed in the Sale 193 final EIS (USDOI, MMS, 2007d). We have updated the assessment for lease sales 212 and 221. The results of this analysis are similar to past analyses. Spills in the marine environment that occur during fall or spring in the open lead or polynya systems and spills that contact the coastlines of Wrangel Island, Herald Island, or the Chukotka coast have the greatest potential to affect polar bears. However, based upon Oil Spill Risk Assessment model runs, the probability of such a spill scenario is very low. For example, if a large spill were to occur, the likelihood of that spill contacting Wrangel Island is <13% over a period of 60 days in summer.

The OSRA model: A large spill from a well blowout is described as a very unlikely event, and we assume that no large oil spills will occur during exploration activities (DEIS, Appendix A, Section 1.1.4).

In the unlikely event of such an oil spill, the extent of take would be influenced greatly by the volume, trajectory, and timing of the spill as well as the period that oil remains in the environment (DEIS, Section 4.4.1.6.3.1.4). If a large oil spill occurred in the vicinity of a polar bear aggregation, any substantial loss of individual bears would represent a major impact. However, the Oil Spill Risk Assessment (OSRA) model estimates the chance of one or more large oil spills from OCS production in the Beaufort Sea to be very low. The most likely number of spills ≥1,000 bbl is zero (USDOI, MMS, 2003a: Appendix A).

The OSRA modeling of oil-spill impacts are based on a combination of factors including the chance of one or more large spills occurring, spill size, spill duration, and current or weather conditions. Spills could occur on land or in the marine environment. Spills into the marine environment have the potential to spread rapidly, depending on water currents, ice, wind, and other weather conditions. Therefore, spills in the marine environment may have a greater potential to affect polar bears. Polar bears present in the vicinity of an oil spill might or might not be contacted by the oil due to avoidance behavior, ice conditions, or weather patterns. It is unclear whether polar bears avoid or are attracted to oil (Geraci and St. Aubin, 1990). Polar bears could come into contact with oil in the open lead system, in pack ice, on shorefast ice, along the coastline, or on barrier islands. This analysis assumes that polar bears contacted by oil or bears that ingested substantial amounts of oil through eating oiled prey or grooming would not survive.

The OSRA model quantifies the percent chance that a large spill (defined as >1,000 bbl for a platform spill and >4,600 bbl for a pipeline spill) could contact important resources areas. We analyze the potential effects from oil spills to determine which polar bear habitat areas would be at highest risk. In the following sections, we evaluate the vulnerability of polar bears to oil spills, describe the potential effects of disturbance from post-spill cleanup activities, the potential effects of prey reduction or contamination, and the anticipated effects to the polar bear.

For the OSRA model, the probability that an oil spill would contact a specific resource area assumes no cleanup or mitigation is in place. The same oil spill mitigation measures described for existing OCS leases would be implemented for future OCS activities. For example, companies operating in the OCS are required to have and implement OSRPs to help prevent oil from reaching critical areas and to remove oil from the environment.

4.4.3.2.4.1. Vulnerability of Polar Bears to Oil Spills.

Beaufort Sea: 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. After an oil spill occurs, the highly toxic aromatic hydrocarbons typically evaporate relatively quickly, sometimes within weeks if the oil is exposed to optimum environmental conditions. If the oil remains trapped in ice, frozen within sea ice for example, then the oil can retain aromatic hydrocarbons for months, until the oil eventually melts out and is exposed to wind and wave action. Although oil toxicity decreases over time with weathering, this does not necessarily decrease the risk from oiling to polar bears, because they are vulnerable to hypothermia once their coat becomes oiled and will continue to ingest oil through grooming in an effort to clean their coats.

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 and await the formation of sea ice. 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. Polar bears have been observed chewing on oil cans and fuel bladders, as well as snow machines and, in one case, a car battery; therefore, it seems unlikely that polar bears would avoid their usual prey items due to oiling. Ingesting oiled prey likely would be a secondary source of mortality from a spill.

Chukchi Sea: Polar bears move north and south with the pack ice in the Chukchi Sea and are vulnerable to spills at any time of the year. In general, polar bears can be encountered throughout the ice-covered waters of the Chukchi 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 along the arctic coasts or on Wrangel or Herald islands in late summer and fall, when they congregate in these areas to feed on walrus and 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. Polar bears may not avoid their usual prey items due to oiling. Ingesting oiled prey would be likely to be a secondary source of mortality from a spill.

Increasing trends in polar bear use of terrestrial habitat in the fall are likely to continue, as sea ice conditions continue to change. In March 2006, more than 4,790-bbl (200,000 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. As demonstrated by this spill, small, chronic leaks in underwater pipelines could result in large volumes of oil being released underwater 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. The MMS regulations require spill-prevention and equipment monitoring, an OSRP, that personnel be trained in appropriate oil spill clean-up techniques, and that clean-up equipment be on hand..

4.4.3.2.4.2. Oil-Spill Analysis.
The following oil spill effects analysis presents conditional and combined probabilities expressed as percent chance. Conditional probabilities assume that a large spill has occurred, and model the chance of that spill contacting a particular environmental resource area (ERA) (see Appendix A of the DEIS). Combined probabilities model the chance of one or more large spills occurring and contacting a particular 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 ERAs and Land Segments (LSs) or Grouped Land Segments (GLSs). Locations of ERAs are found in Maps A.1-2a through 2e and land segments in Maps A.1-3a through 3d of the DEIS. The OSRA model assumes that a spill starts at a specific launch area or pipeline segment. The launch areas and pipeline segments for the Beaufort Sea area are found in Appendix A, Map A.1-4 and for the Chukchi Sea are in Map A.1-5 of the DEIS. An ERA can represent an area important to one or more species or species groups during a discrete amount of time. This section analyzes potential oil-spill impacts to polar bears. 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. These impacts are analyzed in the non-endangered marine mammals section (Section 4.4.2.8.3.1.7) of the DEIS.

4.4.3.2.4.2.1. Oil Spill Analysis, Beaufort Sea

4.4.3.2.4.2.1.1. Conditional Probabilities.
This section discusses the chance that a large oil spill from the Beaufort Sea lease sale area would contact specific ERAs that are important to polar bears. Conditional probabilities assume that a large spill has occurred and that no measures are taken to contain or clean-up the spill.

The estimated chance that one or more large platform and pipeline spills will occur as a result of production from Lease Sales 209 and 217 is 26% over the 26-years of production. This model assumes that development results in a specific amount of oil being produced and that the life of each production fields is 20 years (DEIS, Table A.1-26). For development and production phases, the fate and behavior of a 1,500-bbl oil spill from a platform and a 4,600-bbl oil spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (DEIS, Appendix A).

A 1,500-bbl platform spill occurring during the summer season (between July and September) would cover approximately 9 km^2 after 3 days and 181 km^2 of discontinuous area after 30 days, and could oil an estimated 29 km of coastline (DEIS, Table A.1-6). A meltout spill of the same size from a platform would cover 7 km^2 after 3 days and 143 km^2 of discontinuous area after 30 days, and would oil an estimated 32 km of coastline (DEIS, Table A.1-6). These examples highlight the critical importance of an immediate response from on-site oil spill response personnel and equipment, though winter cleanup may have limited effectiveness, particularly in broken-ice conditions.

A 1,500 or a 4,600-bbl spill could contact ERAs where polar bears may be present (DEIS, Table A.1-16). Approximately 40% of a 4,600-bbl pipeline spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km^2. A spill during broken ice in fall or under ice in winter would melt out in the following summer, potentially causing major impacts to polar bears. Approximately 69% of a 4,600-bbl pipeline spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km^2 (DEIS, Table A.1-7).

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting identified polar bear habitats. Conditional probabilities are based on the assumption that a large spill occurred (for further explanation, see DEIS, 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.1-4 of the DEIS. There are 25 launch areas and 17 pipeline segments considered in the model.

4.4.3.2.4.2.1.1.1. Summer Oil Spills - 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 following discussion summarizes the results for Launch Areas (LAs) 1-25 and pipelines (PLs) 1-17 during summer, unless otherwise specified. The important polar bear habitat during this time period includes 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 (DEIS, Table 4.4.2.6.3-1). 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. There is no difference 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. Again, there is no difference within 60 days, the chance of contact remains at 5% or less. For more information see Appendix A, Tables A.2-65, A.2-66, A.2-71 and A.2-72 of the DEIS.

If groups of land segments are considered, the chance of contact from a large spill contacting the U.S. Beaufort Sea 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 launch area where a large spill could originate (DEIS, Table A.2-89, Maps A.1-3d and A.1-4). After 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 (Table A.2-95). The chance of contact from a large spill originating at a pipeline reaching the U.S. Beaufort Sea coastline within 30 days ranges from 1% from PL16 to a high of 59% from PL8 (DEIS, Table A.2-90). After 360 days, the estimated chance of a large spill contacting the coastline ranges from 36% from PL16 to 69% from PL8 (DEIS, Table A.2-96).

The estimated chance that a large oil spill originating at a LA would contact the shoreline of the Arctic NWR, 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. After 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 the Arctic NWR within 30 days ranges from <0.5% from 9 pipeline segments to a high of 45% from PL14. After 360 days, this rises to a range of 1-49% (DEIS, Appendix A, Tables A.2-89, A.2-90, A.2-95, and A.2-96).

4.4.3.2.4.2.1.1.2. Winter Oil Spills - Barrier Islands and Coastline. The OSRA model estimates the chance of a large oil spill contacting the barrier islands that are important ERAs to polar bears (DEIS, Table 4.4.2.6.3-2). The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during winter. A large spill has a 1% chance or less of contacting Cross Island and No Name Island within 30 days. There is no difference 360 days after a spill, the chance of contact remains at ≤1%. A large spill has a <0.5% chance of contacting Barter Island, Bernard Spit and Arey Island within 30 days. There is very little difference within 360 days the chance of contact remains at 1% or less. For more information, see DEIS, Appendix A, Tables A.2-113, A.2-114, A.2-119 and A.2-120.

If groups of land segments are considered, the chance of contact from a large spill at launch areas reaching the U.S. Beaufort Sea coastline within 30 days ranges from a low of <0.5% at three launch areas to a high of 14% at LA18 (DEIS, Table A.2-137, Maps A.1-3d and A.1-4). The chance of contact from a large spill originating at a pipeline segment 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 a launch area contacts the shoreline of the Arctic NWR within 30 days ranges from a low of <0.5% from seven launch areas to a high of 14% from LA18. The chance that a large oil spill originating at a pipeline segment would contact the shoreline of ANWR within 30 days ranges from a low of <0.5% from two pipeline segments to a high of 12% from PL14 (DEIS, Appendix A, Table A.2-137 and A.2-138).

Increasing trends in polar bear use of terrestrial habitat in the fall are likely to continue, as sea ice conditions continue to change. In March 2006, more than 4,790-bbl (200,000 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. 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 Beaufort Sea 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. The MMS regulations require spill prevention and equipment monitoring.

4.4.3.2.4.2.1.2. 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 or containment efforts. For more background, see DEIS, Appendix A, Section 4.3. The OSRA model estimates the chance of one or more large spill (>1,000 bbl) occurring and contacting any portion of Point Barrow; the Plover area; Thetis, Jones, Cottle or Return islands is <0.5% from 3 days after a spill until 30 days after a spill, when it increases to 1% and remains at 1% from 30 days through 360 days after the spill. The combined probabilities of a large spill (>1,000 bbl) occurring and contacting any portion of Maguire, Flaxman, or Barrier island is <0.5% from 3 days after a spill until 180 days after a spill; the percent chance rises to 1% 360 days after the spill. 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 coastline of the Arctic NWR is 1% from 10-30 days after a spill, 2% 60 days after a spill, 3% 180 days after a spill, and 4% 360 days after a spill.

4.4.3.2.4.2.2. Oil Spill Analysis, Chukchi Sea

4.4.3.2.4.2.2.1. Conditional Probabilities. This section discusses the chance that a large oil spill from the Chukchi Sea lease sale area would contact specific ERAs that are important to polar bears.

Conditional probabilities assume that a spill has occurred and that no clean up or containment efforts occur.

The estimated chance that one or more large platform or pipeline spills will occur as a result of production from lease sales 212 and 221 is 40% over the life of the project. The model assumes that development would result in production of a certain amount of oil, and that the life of the production field is 25 years (DEIS, Appendix A, Table A.1-28). For development and production phases, the fate and behavior of a 1,500-bbl oil spill from a platform and a 4,600-bbl oil spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (DEIS, Appendix A).

A 1,500-bbl spill from a platform occurring during the summer season (July-September) would cover approximately 29 km^2 after 3 days and 577 km^2 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 km^2 after 3 days and 188 km^2 of discontinuous area after 30 days, and would oil an estimated 30 km of coastline (DEIS, Appendix A, Table A.1-11). A 4,600-bbl spill from a pipeline occurring during the summer season would cover approximately 51 km^2 after 3 days and 1008 km^2 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 km^2 after 3 days and 332 km^2 of discontinuous area after 30 days, and would oil an estimated 51 km of coastline (DEIS, Appendix A, Table A.1-12). These examples highlight the critical importance of an immediate response from onsite oil-spill response personnel and equipment, although winter cleanup may have limited effectiveness, particularly in broken-ice conditions.

A 1,500- or a 4,600-bbl spill could contact ERAs where polar bears may be present (DEIS, Appendix A, see especially Table A.1-17). Approximately 44% of a 4,600-bbl pipeline spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 1008 km^2. 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-bbl pipeline spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 332 km^2 (DEIS, Tables A.1-11 and A.1-12).

The OSRA model calculates conditional probabilities (expressed as a percent chance) of a spill contacting identified polar bear habitats (ERA polygons, land segments, or grouped land segments). Conditional probabilities are based on the assumption that a spill has occurred (for further explanation, see DEIS, 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 DEIS, Appendix A, Map A.1-5. There are 15 launch areas and 11 pipeline segments considered in the model.

4.4.3.2.4.2.2.1.1. Summer Spill - 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 coast of the Chukchi Sea (unpublished polar bear den database, 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 upon seals.

The OSRA model predicts the chance of a summer oil spill contacting the ERAs and coastal areas that are important resource areas to polar bears. This information is summarized in DEIS, Table 4.5.2.6.3-1. 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 spill has a

2% chance or less of contacting Wrangel Island or Ostrov Kolyuchin and a 1% chance or less of contacting Herald Island 30 days after a spill, for all potential launch areas and pipeline spills. There is no difference 360 days after a spill, 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 30 days after a spill, for all potential launch areas and pipeline spills. The percent chance rises to 7% at 360 days after a spill. For the Barrow, Browerville, Elson Lagoon area, the percent chance of contact from a summer spill is 8% at 30 days after a large spill and 13% at 360 days after a spill. For more information see Appendix A, Table A.3-33, A.3-36, A.3-39, A.3-42 of the DEIS.

If groups of land segments are considered, the chance of contact from a summer spill originating at a launch area or pipeline in the Chukchi Sea lease-sale area reaching the U.S. Beaufort Sea coastline within 30 days varies from <0.5% at 18 launch areas and pipelines, to a high of 10% at LA13. The level of risk is variable due to the effects of wind, current, and proximity to shore and depends on the launch area or pipeline segment where the spill originates (DEIS, Table A.3-45, Maps A.1-3d and A.1-5). After 360 days, the percent chance remains at a low of <0.5% at 10 launch areas and pipelines, and rises to a high of 23% at LA8 (DEIS, Table A.3-48). The chance of contact from a summer spill originating at a launch area or pipeline in the Chukchi Sea lease-sale area reaching the U.S. Chukchi Sea coastline within 30 days varies from <0.5-22% (LA 11) for launch areas, and from <0.5% (PLs 4 and 7) to 33% (PL 9) and 35% (PL 6) for pipelines. After 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 launch area or pipeline in the Chukchi Sea lease-sale area reaching the Russian Chukchi Sea coastline within 30 days varies from <0.5% at 12 launch areas and pipelines, to a high of 20% at LA9 and 20% at PL1 (DEIS, Table A.3-45, Maps A.1-3d and A.1-5). After 360 days, the percent chance remains at a low of 1% at 8 launch areas and pipelines, and remains at a high of 20% at LA9 and PL1 (DEIS, Table A.3-48.)

The percent chance that an oil spill originating at a launch area or pipeline in the Chukchi Sea lease-sale area would contact the Chukchi Sea spring lead system is <0.5-14% at 30 days after a spill, and the percent chance remains the same at 360 days after a spill. The percent chance that an oil spill originating at a launch area or pipeline in the Chukchi Sea lease-ale 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. After 360 days, this rises to a range of <0.5-85% at LA11 and 82% at PL5 (DEIS, Appendix A, Table A.3-33 and A.3-36).

4.4.3.2.4.2.2.1.2. Winter Spill - Barrier Islands and Coastline. A winter spill 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 US and Russian coast of the Chukchi Sea (unpublished polar bear den database, 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 predicts the chance of a winter oil spill contacting the ERAs and coastal areas that are important resource areas to polar bears. This information is summarized in Table 4.5.2.6.3-2 of the DEIS. 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 launch areas 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 launch areas 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 DEIS, Appendix A, Table A.3-57 and A.3-60.

If groups of land segments are considered, the chance of contact from a winter spill originating at a launch area or pipeline in the Chukchi Sea lease-sale area reaching the U.S. Beaufort Sea coastline 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 action area reaching the U.S. Chukchi Sea coastline 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 launch areas and 2-38% for pipelines. The chance of contact from a winter spill originating in the Chukchi Sea lease-sale area reaching the Russian Chukchi Sea coastline within 30 days varies from <0.5-8% for launch areas and pipelines. After 360 days, the percent chance remains <0.5-8% for launch areas and from <0.5-9% for pipelines. The level of risk is variable due to the effects of wind, current, and proximity to shore and depends on the launch area or pipeline segment where the spill originates (DEIS, Tables A.3-69 and A.3-72, Maps A.1-3d and A.1-5).

The percent chance that an oil spill originating in winter at a launch area in the Chukchi Sea lease-sale area would contact the Chukchi Sea spring lead system is <0.5-16% at 30 days after a spill, and <0.5-23% at 360 days after a spill. The percent chance that an oil spill originating in winter at a pipeline in the Chukchi Sea lease-sale area would contact the Chukchi Sea spring lead system is <0.5-26% at 30 days after a spill and <0.5-35% at 360 days after a spill. The percent chance that an oil spill originating in the Chukchi Sea lease-sale area would contact the Chukchi Sea polynya areas within 30 days of a spill ranges from <0.5-18% at launch areas and <0.5-32% at pipelines. After 360 days, this rises to a range of <0.5-33% at launch areas <0.5-39% at pipelines (DEIS, Appendix A, Table A.3-57 and A.3-60).

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

The combined probabilities of a large spill (>1,000 bbl) occurring and any portion of that spill contacting any portion of Wrangel Island, Herald Island, Ostrov Kolyuchin, Barrow, Browerville, or Elson Lagoon is <0.5% from 3 days after a spill until 360 days after a spill. The combined probabilities of a large spill occurring and any portion of that spill contacting any portion of the Chukchi Sea spring lead system is 5% after 30 days and 7% after 360 days. The combined probabilities of a large spill occurring and any portion of that spill contacting any portion of the Point Lay area polynya system (also identified as a subsistence area) is 5% after 30 days and 8% after 360 days. The combined probabilities of a large spill occurring and any portion of that spill contacting any portion of the Wainwright area polynya system (also identified as a subsistence area) is 5% after 30 days and 7% after 360 days. The combined probabilities of a large spill occurring and any portion of that spill contacting any portion of Point Barrow or the Plover Islands is <0.5% after 30 days and 1% after 360 days.

For grouped land segments, the combined probabilities of a large spill occurring and contacting the Chukchi Sea polynya area offshore is 13% after 30 days and 17% after 360 days. The combined probabilities of a large spill occurring and contacting any portion of the Russian Chukchi coastline is 1% after 30 days and after 360 days. The combined probabilities of a large spill occurring and contacting any portion of the U.S. Beaufort Sea coastline is <0.5% after 30 days and 1% after 360 days. The combined probabilities of a large spill occurring and contacting any portion of the U.S. Chukchi coastline is 6% after 30 days and 11% after 360 days (DEIS, 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 amounts of oil contacting the coastline.

4.4.3.2.4.3. Chronic Small Spills.
The effects of chronic small or low-volume spills on polar bears would depend on the location and timing of each spill, as well as the speed and success rate of cleanup efforts, and of efforts to haze bears away from the spill area. Small or low-volume spills are defined as spills <1,000 bbl.

<u>Beaufort Sea</u>: Between 1989 and 2000, there have been 1,178 spills of <500 bbl on the Alaska North Slope. There have been six spills that were between 500 and 1,000 bbl. The total volume of all 95 spills combined was 306,277 gal or 7,292 bbl (DEIS, Table A.1-29). An estimated 89 small crude oil spills of <500 bbl could occur during the 20-year oil-production period (DEIS, Appendix A, Table A.1-30), an average of more than 4 per year. The average crude oil spill size is 126 gal (3 bbl) for spills <500 bbl. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined oil spills could occur during the 20-year oil-production period (DEIS, Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume oil spills could occur during each year over the 20-year production period. To date, there is no indication that polar bears have been impacted by any of these spills.

If one or more small-volume spills were to occur in close proximity to Bernard Spit or Cross or Barter island in late summer or fall, 60 bears or more could be present (Miller et al., 2006). There also is the potential for bears to forage on oiled carcasses, which would bring them into contact with oil.

<u>Chukchi Sea</u>**:** An estimated 178 small crude oil spills <500 bbl could occur during the 25-year oil-production period (DEIS, Appendix A, Table A.1-32), an average of more than 7 per year. The average crude oil spill size is 126 gal (3 bbl) for spills <500 bbl. The average refined oil spill size is 29 gal (0.7 bbl), and an estimated 440 refined oil spills could occur during the 25-year oil-production period (DEIS, Appendix A, Table A.1-32), an average of 17.6 per year. Overall, an estimated 25 small-volume oil spills could occur during each year of the 25-year production period.

Small-volume spills from the Chukchi Sea lease-sale area are unlikely to reach the Russian Arctic coasts or Wrangel or Herald islands. If one or more small-volume spills were to occur in close proximity to polynya or lead systems where bears were foraging, they may become oiled. There also is the potential for bears to forage on oiled carcasses, which would bring them into contact with oil.

4.4.3.2.4.4. Spill-Response Activities. Conditional and combined probabilities do not factor in the effectiveness of oil-spill response activities to large or small spills. Oil-spill responses (cleanup or containment efforts) vary from highly effective in calm, open-water conditions to largely ineffective during unfavorable or broken-ice conditions. The MMS requires that each operator have an approved OSRP 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, dispersants or other resources. Both Cross and Barter island have been identified in spill-response documents and on maps as important habitat for polar bear (Alaska Clean Seas Technical Manual, 2007). Currently, there are no sensitive areas identified for polar bears in the Chukchi Sea. If the FWS identifies sensitive areas or establishes critical habitat through the ESA process, these areas would be identified in the Alaska Clean Seas Manual and would receive special attention in the event of a spill.

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 on the location of the spill, oil spill response could take some time to begin. Oil-spill-response equipment is cached in Barrow as well as 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, it is unlikely that an oiled bear would survive without human intervention.

To adequately protect polar bears and their habitat from the threat of a large oil spill, or chronic small spills, the mitigation measures in place must be adaptable to continued changes in polar bear distribution and habitat use, for example, increasing use of the coastline in late summer and fall. Equipment and trained crews need to be able to respond rapidly to a spill as soon as it is discovered. The effectiveness of oil spill response measures will depend largely on the location of the spill, the distances involved, the season, and the weather. To date, there is no indication that small spills on the North Slope have impacted polar bears. Clean up efforts for small spills near shore and on shore have been effective at removing oil and oiled substrate before impacts could occur. MMS is not aware of any impacts related to OCS activities from small spills offshore in the Beaufort or Chukchi seas that have reached the water before containment occurred. We anticipate that clean up methods will continue to improve and that current methods will continue to be effective in containing and removing small spills with only minor impacts.

4.4.3.2.4.5. Prey Reduction or Contamination. Ringed seals may make up as much as 98% of polar bear diet in the Beaufort Sea. Less information on Chukchi Sea polar bear diets is currently available. 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 Southern Beaufort Sea and/or Chukchi Sea 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 may not avoid oiled carcasses, and ingestion of oiled prey is likely to have lethal effects. Oritsland et al. (1981) 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.

4.4.3.2.4.5. Conclusion, Spill Effects.

Documented impacts to polar bears to date in the Alaskan Arctic by the oil and gas industry appear minimal. Due primarily to increased concentrations of bears on parts of the coast, the relative oil spill risk to the population may be increasing. Close cooperation among MMS, the FWS, OCS operators, and oil spill response personnel will help to ensure that the level of effect does not increase.

We conclude that if a large offshore oil spill occurred, a potentially significant impact to polar bears could result if clean up efforts were unsuccessful and areas in and around polar bear aggregations were oiled during a time period when polar bears were congregated there; however, we consider this to be a very unlikely event. The biological potential for polar bears to recover from any population level perturbation is low due to their low reproductive rate (Amstrup, 2000). Based on OSRA analysis, the estimated chance of a large spill occurring over the 20-year life of production in the Beaufort Sea is 26% (DEIS, Table A.1-26). The combined probability of one or more large oil spills occurring and contacting any portion of the Beaufort Sea coastline is <5% within 60 days (DEIS, Table A.2-160). Based on OSRA analysis, the estimated chance of a large spill occurring over the 25-year life of production in the Chukchi Sea is 40% (Table A.1-28). The combined probability of one or more large oil spills occurring and contacting the U.S. Chukchi Sea coastline is 8% within 60 days, and 1% for the Russian Chukchi Sea coastline. Overall, the likelihood of a large spill occurring, not being contained, and contacting an area during a time period when polar bears are concentrated in that area is very small, < 10%. To date, small spills have not resulted in impacts to polar bears in the OCS. Therefore, we anticipate that petroleum spills are unlikely to have more than minor impacts to polar bears.

4.4.3.2.1.5. Anticipated Effects from Habitat Loss and Degradation.

Summary: There would not be any permanent loss of polar bear habitat during exploration and delineation activities in the Alaskan Arctic OCS. Some temporary displacement of polar bears and their prey (e.g., ringed seals) may occur. The level of this impact would depend upon the location and the duration and timing of the exploration activities, but is expected to be minor. There could be some loss of habitat from development and production activities that would continue over the life of a production platform and the associated infrastructure, which may include a shore base, elevated pipeline, access roads, or other facilities (estimate approximately 20-40 years). The footprint of these structures would be small compared to the amount of habitat currently available. Further evaluation would occur if a Development and Production Plan (DPP) were to be submitted to MMS at a future date and additional mitigation measures would be implemented as necessary. At this time, critical habitat has not yet been designated for the polar bear. Once critical habitat has been designated, any DPPs that are submitted will be reviewed for potential impacts to critical habitat as well as site specific impacts to polar bears. Oil fields located within the OCS would be linked to existing infrastructure if possible in order to minimize technological and financial constraints. MMS anticipates that habitat losses from OCS activities would be few and would have minor impacts on polar bears.

Beaufort Sea

<u>Exploration:</u> There would not be any permanent loss of polar bear habitat during O&G exploration and delineation activities. Some temporary displacement of polar bears and their prey (e.g., ringed seals) may occur during exploration activities, particularly on-ice activities, in nearshore waters. The level of this impact would depend on the extent of habitat and the duration and timing of the activities.

We expect exploration of existing federal leases in the Beaufort Sea OCS to continue. OCS leases currently held by industry are the result of lease sale 186 held in September, 2003, lease sale 195 held in March, 2005 and lease sale 202 held in March 2007. Leaseholders and others will continue to investigate the potential for oil and/or gas production in the future. Most exploration on federal leases occurs during the open water season. Open water exploration is not likely to displace polar bears. On-ice exploration activities may cause some polar bears to be displaced from relatively small areas, generally no more than 20 lease blocks and generally for no more than three seasons. On ice seismic exploration activities include the placement of temporary support facilities and ice roads. This may include accommodations for as many as 100 workers. Support for the camps may include lights, generators, snow removal, water plants, wastewater plants, dining halls, sleeping quarters, mechanical shops, fuel storage, camp moves, landing strips, aircraft support, health and safety facilities, a data recording facility and communication equipment. On-ice exploration is usually limited to nearshore (State) waters by safety and technical concerns.

Exploratory drilling may occur on some subset of lease blocks if seismic exploration indicates that a potential well site is promising. Exploratory drilling on Federal leases generally occurs during the open water season and is not likely to displace polar bears. In nearshore (State) waters, some exploratory drilling could occur on ice or from drilling ships which have been frozen in place over winter. Exploratory drilling and associated support activities and features could include: transportation to site; setup of up to 100-person camps and support camps (lights, generators, snow removal, water plants, wastewater plants, dining halls, sleeping quarters, mechanical shops, fuel storage, camp moves, landing strips, aircraft support, health and safety facilities, data recording facility and communication equipment);

building gravel pads; building gravel islands with sandbag and concrete block protection; ice islands; ice roads; gravel hauling; gravel mine sites; road building; pipelines; electrical lines; water lines; road maintenance; buildings and facilities; operating heavy equipment; digging trenches; burying and covering pipelines; sea lift; water flood; security operations; dredging; moving floating drill units; helicopter support; and drill ships such as the SDC, CANMAR Explorer III, and the Kulluk. These exploration activities would be expected to temporarily displace polar bears from the immediate area during the exploration period, which would have negligible or minor effects to polar bears and would not adversely effect the population.

Most exploration wells are not expected to result in production. For those wells which do not become production sites, wells will be capped below mud level and all external structures will be removed after exploration is complete. The historical trend in the Beaufort Sea OCS has been that there have been 30 exploration wells drilled, but none have resulted in production. The Beaufort Sea Multi Sale EIS (Sales 186, 195 and 202) projected that 36 exploration and delineation wells would be drilled resulting in 6 fields being discovered as a result of the 3 sales. That EIS projected that 8 exploration wells would have been drilled by 2008, however, none have been drilled to date and many leases have already been relinquished by the lease holders.

Development and Production: The Proposed Action could increase the footprint of industry activities on the North Slope. Some long-term habitat loss would be associated with production activities. Critical habitat has not yet been designated for polar bears. This lease sale would add incrementally to the level of exploration currently ongoing on the North Slope, and to temporary displacement of polar bears and their prey species. We expect the OCS activities to have only minor effects on polar bears. If any of the lease blocks move forward from exploration to production, further evaluation of potential effects will take place at the time that MMS receives a DPP. In brief, an offshore platform would include pipeline buried below ice gouging depths to a shore-based facility, or directional drilling of below sea bed pipeline to a shore based facility. We assume that some small amount of foraging habitat might become unavailable for the lifetime of the production platform and or facility. Some small amount of denning habitat might become unavailable for the lifetime of the production platform and or facility. The lifetime of a production facility is estimated to be several decades; all above seabed level structures would be removed at the end of that period. If built, man-made gravel islands might remain at the end of production. We do not anticipate that these activities would result in any direct or indirect mortality of polar bears or would have more than minor effects on polar bears. We do not anticipate that these activities would adversely effect the polar bear population.

Direct impacts to polar bear denning habitats could arise from the facility footprint, or from shore based facilities built to support the oil field (pipeline, access roads, pump stations, camp facilities, etc.). We can only speculate about the size and location of permanent developments associated with a future phase of oil production, but developments on offshore barrier islands, a habitat preferred by polar bears, could have moderate effects over time if multiple developments were to take place in preferred barrier island habitats. At this time, MMS anticipates that if development occurred, the most likely scenario would be the development of a single production platform. Onshore developments would originate at a pipeline landfall, the location of which is unknown. The pipeline and associated developments conceivably would then be the shortest, most cost-effective route to connect with pre-existing support infrastructure. Polar bears currently move through and around the oil fields. Some bears may be drawn to investigate new developments, while others will avoid all contact. In general, young males are more likely to investigate activities, while females with cubs are more likely to avoid areas by a greater distance. . Indirect habitat losses could result from polar bears not using habitats near sites of industrial activity. We expect effects to polar bears from currently planned and reasonably foreseeable actions to be minor. Future potential impacts would depend on the number and location of developments and potential changes in polar bears' use of the nearshore environment due to climate change. Further evaluation would occur at the time that DPPs were proposed and no permanent adverse modification of critical habitat would be permitted.

Chukchi Sea

Exploration: A temporary loss of polar bear foraging habitat could result from offshore exploration activities. This would have minor effects on foraging habitat availability. The level of displacement would depend on the level of exploration occurring, the location, and the duration of the activity, but is anticipated to be temporary and spatially transient. No loss of polar bear denning habitat is anticipated from exploration since the lease sale area doesn't encompass denning habitat in the Chukchi Sea planning area. Seismic exploration and exploration and delineation wells are all expected to have temporary effects of not more than a few seasons in a particular area. Any infrastructure from exploration or delineation wells would be removed below the mud line after exploration was complete. Drill ships, platforms, and other infrastructure would not remain in an area unless a large oil field was discovered.

Additional leasing could add incrementally to the level of exploration currently ongoing in the Chukchi Sea and could lead to temporary displacement from foraging habitat for the polar bear and their prey species. We expect exploration activities in the Chukchi Sea to be primarily offshore during the open-water season. We expect exploration activities from this lease sale to have no more than minor effects on polar bears.

Development and Production: No offshore developments are currently planned in the Chukchi Sea, and production is not considered reasonably foreseeable at this time. If a large oil field is discovered, and exploration leads to production in the Chukchi Sea, permanent loss of a relatively small amount of denning or foraging habitat could occur. Production facilities could include an offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure. It was assumed that onshore developments would originate at a pipeline landfall, location presently unknown. The pipeline and associated developments conceivably would then be the shortest, most cost-effective route to connect with pre-existing support infrastructure. Additional airstrip construction or use of overland ice roads/pads is not anticipated. Indirect habitat losses could result from polar bears not using habitats near sites of industrial activity.

Conclusion: Under the Proposed Action, the footprint of activities ongoing in Northern Alaska could increase. Critical habitat has not yet been designated for polar bears, but would likely influence the placement of facilities onshore, as well as the location and timing of exploration activities.

To date, mitigation measures have been effective in the Beaufort Sea and production activities have not had more than moderate impacts to polar bears and have not adversely impacted the population. Similar mitigation measures would be in place in the Chukchi Sea if production plans were developed. Current ITRs in the Chukchi Sea do not include production. FWS anticipates having critical habitat delineated before ITRs are renewed in 2013.

The MMS can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production. MMS would not authorize a future project if it were likely to jeopardize the continued existence of the polar bear or result in adverse modification of designated critical habitat as determined by FWS. If exploration leads to a DPP being submitted to MMS, further analysis of the specifics of the plan will take place at that time. MMS anticipates that the level of exploration and development considered reasonably foreseeable in the Arctic OCS would lead to habitat losses that would not have more than minor impacts to polar bears.

4.4.3.2.1.6. Anticipated Effects from Seismic Noise.

Summary: Open water seismic surveys take place in areas (deep open water areas offshore) where polar bears are infrequently encountered. Polar bears typically swim with their heads above water and are therefore less susceptible to injury from seismic airguns than other marine mammals. Open water seismic activities are not likely to have more than negligible impacts to polar bears. Activities associated with on-ice seismic surveys have the potential to disturb foraging or denning polar bears. Bears are more likely to be disturbed by rollogons, snowmachine traffic, camp construction and ice road transportation than by the seismic airgun itself. Mitigation measures currently in place through the LOA process have been effective at mitigating the potential for disturbance to denning or foraging bears. With mitigation in place, MMS anticipates no more than minor impacts to polar bears from seismic noise and associated activities.

Beaufort and Chukchi seas: Open-water seismic surveys are occurring on existing leases and other areas of the Chukchi Sea and Beaufort Sea OCS. On-ice seismic surveys are occurring on existing leases and other areas of the Beaufort Sea OCS. These activities are anticipated to continue into the reasonably foreseeable future.

Females in dens, both on sea ice and onshore, are at risk to disturbance from any vehicular traffic or noise that occurs as a result of on-ice seismic activities. There is one record of seismic activity disturbing a bear while she was in a den (NRC, 2003), and another of a female in a den being disturbed by traffic on a nearby ice road (C. Perham, FWS, pers. commun., 2009). Most effects from seismic activity are expected to be negligible due to mitigation measures typically required, such as conducting den surveys prior to the onset of work and avoiding any known dens by a prescribed distance.

Polar bears are less sensitive to disturbance from open-water seismic activities than many marine mammal species. On-ice seismic activities are not anticipated to occur on the Chukchi Sea OCS because the bathymetry and ice-formation patterns in the Chukchi Sea do not facilitate the safe use of this technology. With mitigation measures in place, we expect negligible effects to polar bears from open-water seismic activities in the Chukchi Sea OCS and Beaufort Sea OCS. Some displacement of polar bears from open-water seismic surveys may occur, but these effects are expected to be short term. .

Conclusion: The effects of open-water seismic activities on polar bears are anticipated to be negligible. With mitigation measures in place, we expect only minor impacts to polar bears from on-ice seismic operations in the Beaufort Sea, and no adverse impacts to the polar bear population.

4.4.3.2.1.7. Anticipated Effects from Changes in the Physical Environment.

We expect current trends to continue and to accelerate over time (IPCC, 2007). Summer sea ice in the Arctic is anticipated to disappear by approximately 2030 (Wang et al. 2009). Ongoing climate change is expected to have a major effect on polar bears within the next 40-50 years, possibly leading to their extirpation in Alaska. MMS activities in the Arctic OCS are not anticipated to affect this rate of change.

Beaufort and Chukchi seas: General trends over the past several decades in Alaska include a continuing decline in the temporal and spatial extent of winter sea ice. Land fast ice is forming later in the year, and retreating earlier. There is less multi-year ice than in previous decades. Increased open water periods are leading to an increase in the number and severity of storms, which is in turn increasing the rate of coastal erosion. These trends are affecting polar bears by increasing the amount of time that polar bears spend on shore and possibly increasing their reliance on marine mammal carcasses found along the coast as a food source. Polar bears may also be spending more time fasting on sea ice that has retreated off of the continental shelf over areas too deep for ice seals. Polar bears may be swimming longer distances between ice floes and between ice and shore, which causes increased energy expenditures and increases the potential for drowning. There is some indication that polar bears are denning on shore more frequently, possibly because there is less stable multi-year ice available for dens. Coastal erosion may decrease the stability or availability of coastal den sites, or conversely may create some new bluffs available for den sites. A decrease in snow fall and an increase in temperature may lead to less stable snow pack which could result in polar bear dens and ringed seal lairs collapsing more frequently. Any substantial decrease in the number and availability of ringed seals would lead to a decrease in the number of polar bears, as these two populations are tightly linked. These climactic trends are occurring on a temporal and spatial scale that is not influenced by the Proposed Action.

Conclusion: The level of effect of changes in the physical environment on polar bears is anticipated to be major, and to have adverse impacts to the polar bear population. The Proposed Action is not anticipated to contribute to these large scale temporal and spatial trends.

Conclusion: Anticipated Effects on the Polar Bear from the Proposed Action. We anticipate that current levels of exploration under the Proposed Action will continue with potential small increases in certain activities. We anticipate that impacts to polar bears from vessels, aircraft, terrestrial vehicles and seismic noise will primarily be short-term, localized disturbances that will not adversely effect the population. We anticipate that subsistence harvest in the Alaskan OCS will continue at or below sustainable levels and that this will result in the direct mortality of no more than 40 polar bears per year. The level of harvest will not be influenced by the Proposed Action. Trends in climate change are anticipated to continue and to impact foraging and denning behavior of polar bears and to adversely impact the population over time. The Proposed Action will not directly or indirectly influence the effects of climate change.

The Proposed Action, with existing MMS operating regulations and the typical mitigation measures imposed by FWS, is not likely to adversely affect the polar bear.

4.4.4. Cumulative Effects

The cumulative effects analyses below evaluate the past, present, and reasonably foreseeable activities to threatened and endangered species (the Steller's eider, the spectacled eider, the Kittlitz's murrelet, yellow-billed loon, and the polar bear) under FWS jurisdiction in the Alaskan Arctic in combination with effects of the Proposed Action. The analysis includes effects from Federal, State, and local activities, both offshore and onshore activities and both oil and gas-related and non-oil and gas related. The cumulative analysis includes consideration of the influence of dynamic climate and anticipated change in the environment. The effects are addressed quantitatively to the degree possible, using known types, levels, and trends of both oil and gas activities and non-oil and gas activities. Impacts that cannot be estimated quantitatively are described qualitatively.

Existing and anticipated impacts to threatened and endangered species arise from a number of sources, including community development; transportation; tourism; oil and gas exploration and development on private, State, and Federal lands; and climate change. Oil and gas exploration activities include vessel presence and noise, aircraft presence and noise, collisions, and seismic-airgun noise. Other than the pending Liberty and existing Northstar developments, production of oil or gas from existing OCS leases in the Chukchi and Beaufort seas is speculative. Oil and gas development activities include those of exploration (to differing degrees) and hunting, habitat loss, petroleum spills, and other effects. In the following section, we describe how these sources of impact may operate in the Chukchi and Beaufort seas.

4.4.4.1. Threatened and Endangered Birds

Summary. Marine and coastal areas of the North Slope are commonly perceived to be a pristine environment, yet there are a number of past and existing sources of harm, an increasing number of threats, and anticipated environmental changes, that are negatively affecting and are anticipated to continue to negatively affect spectacled and Steller's eiders, Kittlitz's murrelets, and yellow-billed loons in the project area well into the future.

Primary considerations include:

- The most important impacts to threatened and endangered birds in the action area likely will arise from continued climate change and the loss or expansion of habitats important to these birds and any changes in breeding chronology or trophic asynchrony. As these species are already imperiled, an inability to adapt to a changing environment could negatively affect their distribution or abundance. Climate-related changes will continue to occur to bird habitats along the Beaufort Sea and Chukchi Sea. With the exception to Steller's eiders, impacts from climate change can reach a greater extent than all other anticipated effects from other impact sources combined.
- 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 74% were shot. It is unclear if the effects of a similar harvest are 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).
- Uncontrolled vessel and aircraft disturbance could continue to harm ESA-listed birds in nearshore brood-rearing or molting areas. Chronic stress during sensitive life stages, especially the molt, likely would lead to long-term changes in survival and productivity. Seismic surveys and other exploration activities for existing OCS leases in the Chukchi Sea require specific mitigation or avoidance measures that reduce impacts to marine and costal birds to a negligible level.
- Collisions with existing structures (production facilities on State lands, power lines, communication towers, etc.) in coastal areas could continue at a low rate. Preventive measures were not required for most of these structures, and special lighting protocols likely would not be implemented on existing developments. New development present additional sources of collision hazard, if preventive measures are not taken. Collisions, however, do not appear to be a significant source of mortality.
- Bird predator species, especially foxes and ravens, are anticipated to continue to expand in distribution and abundance due to a lack of effective control over access to human-use foods or garbage and an increasing abundance of nesting or denning sites. The adverse effect these predators have on ESA-listed bird populations is not clearly understood and is partially offset by small mammal-population cycles; however, the relationship appears to be out of natural ecological balance and will only continue to negatively affect ESA-listed bird populations without concerted management action.
- Spills, particularly in offshore areas, pose the greatest threat to birds in marine areas. Existing and anticipated future increases in vessel traffic, especially from tourism or shipping, could increase the chance of a marine accident. Barring these events, deliveries of bulk fuel to coastal communities pose the greatest chance of a large non-crude oil spill in the marine environment.

While many of these negative influences are difficult or impossible to control, increased attention to minimizing these effects could reduce anthropogenic sources of stress or mortality to ESA-listed birds, especially listed eiders. As it remains unclear what factor(s) is most affecting eider populations, changes in eider populations are difficult to predict. We anticipate that existing trends would continue and ESA-listed eider populations would stabilize. While little information exists for the Kittlitz's murrelet in the Chukchi Sea, recent surveys indicated a surprising abundance of post-breeding Kittlitz's murrelets immediately west of Barrow (Renner, Hunt, and Kuletz, 2008). Additional surveys are needed to verify if there is consistent use of this area by Kittlitz's murrelets. Similarly, areas important to yellow-billed loons are currently being studied by the U.S. Geological Survey with partial funding from MMS (Rizzolo and Schmutz 2008).

Seismic surveys could continue. No more than two drill rigs could operate in the Chukchi Sea or Beaufort Sea at any one time. No more than six seismic-surveying activities per sea could be completed during a season. This level of activity could extend further into the future as new leases are granted. While MMS actions likely could result in a small incremental increase in some sources of potential impacts (e.g., vessel and aircraft traffic), required mitigation measures would limit these sources to proportionately fewer impacts compared to other similar, but unrestricted sources of impact in this area.

Impacts to threatened and endangered birds from (1) continued community and oil and gas infrastructure developments, (2) collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic, all unrelated to OCS leasing activities, would continue to have a combined negative, moderate level of effect. The greatest source of large non-crude oil spills would continue to arise from bulk-fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could dramatically increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on ESA-listed bird populations in the Chukchi Sea. Continued climate change is likely to result in major effects to ESA-listed birds.

4.4.4.1. Cumulative Effects to Threatened and Endangered Birds from the Proposed Action

Beaufort Sea: The anticipated effects of the Proposed Action are combined with the anticipated effects of other existing and other reasonably foreseeable sources of impact to determine the cumulative effects for this alternative. The Proposed Action could result in an increase in the number of active leases in the Beaufort Sea OCS. Some of the existing leases will not be explored, and some were explored and will not be evaluated further by the time the lease lapses. While there may be an initial increase in the number of active leases following a sale, there will be a gradual decline in active leases over time.

Seismic surveys could continue. No more than two drill rigs could operate in the Beaufort Sea at any one time. No more than six seismic-surveying activities could be completed in each sea during a season. The recent level of activity is less than about half that level. These seismic activities likely would extend further into the future as new leases are granted (leases would last for a 10 year period), beyond the expiration period for existing leases. While MMS-authorized actions could result in a small incremental increase in some sources of potential impacts, required mitigation measures would limit these sources to proportionately fewer impacts compared to other unrestricted sources of impact in this area.

Impacts to ESA-listed birds from (1) continued community and oil and gas infrastructure developments, (2) collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic, all unrelated to OCS leasing activities, would continue to have a negative, moderate level of effect on threatened eiders. The greatest source of large non-crude oil spills would continue to arise from bulk-fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could dramatically increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on threatened and endangered birds. Continued climate change is anticipated to result in a major level of effect to threatened and endangered birds.

4.4.4.1.1. Cumulative Effects of Vessel Presence and Noise.

Section 3.1.3.2 describes the general past and present vessel-traffic patterns in the Beaufort Sea. Existing information indicates an increasing amount of vessel traffic, particularly in tourism and research vessels in the Arctic, such as those seeking to explore and study Arctic regions via the Northwest Passage. We anticipate this trend to continue into the reasonably foreseeable future. These vessels are free to navigate open waters where they could encounter and disturb Steller's and spectacled eiders and candidate bird species. For example, traffic between the Beaufort Sea and the Bering Sea could pass through areas seasonally important to spectacled eiders, such as the Ledyard Bay Critical Habitat Area.

There is a high level of interest in using the Northwest Passage as a shipping route to decrease the distance ships would have to travel between the Pacific Ocean and the Atlantic Ocean. Increasing military activities also are anticipated. As with tourism and research traffic, both commercial and military large-vessel traffic could disturb large numbers of ESA-listed birds. Uncontrolled vessel disturbance from anticipated tourism, research, shipping, and military vessels could result in chronic, long-term disturbances to ESA-listed birds, especially during the sensitive molting period in Ledyard Bay.

Oil and gas exploration and development in near-shore waters under state jurisdiction could add to disturbance potential experienced by Steller's and spectacled eiders in the Beaufort and Chukchi Sea regions, however there may be mechanisms via the state permitting process to implement mitigation measures to reduce vessel impacts to ESA-listed birds in the Alaskan Arctic.

Mitigation measures required on ongoing and future exploration and development activities on existing leases or surrounding waters avoid or minimize adverse effects to ESA-listed birds in the Alaskan Arctic.

Conclusion: Vessel impacts unrelated to the Proposed Action are anticipated to result in a continued minor cumulative effect on ESA-listed birds. While activities under the Proposed Action could result in an incremental increase in the total number of vessels operating in the Alaskan Arctic, these vessels would have proportionately fewer impacts compared to other unrestricted vessels operating in this area and the net cumulative effect to ESA-listed birds would be unchanged.

4.4.4.1.2. Cumulative Effects of Aircraft Presence and Noise.
Most aircraft on the North Slope are operated without altitude or route restrictions to protect ESA-listed birds. Some traffic associated with State oil and gas operations is restricted to protect certain species that may also benefit ESA-listed birds (ADNR, 2008). Frequent low-level flights associated with freight, intercommunity travel, research studies, and oil and gas operations likely impact birds. Any adverse effects are anticipated to continue. We have no evidence to suggest that these activities are impacting ESA-listed birds and these effects are anticipated to be negligible.

The number of nesting Steller's or spectacled eiders that would be exposed to low-level flights associated with OCS oil and gas development on existing leases or surrounding waters is low, because the potential direct flight from an airbase to offshore drilling sites within the OCS primarily would be over coastal waters. Mitigation measures imposed on future exploration and development activities avoid or minimize adverse effects to ESA-listed birds along the Alaskan Arctic.

Conclusion: Aircraft impacts unrelated to the Proposed Action are anticipated to result in a continued negligible cumulative effect on threatened and endangered birds. While activities under the Proposed Action could result in an incremental increase in the total number of aircraft operating in the Alaskan Arctic, these aircraft would have proportionately fewer impacts compared to other unrestricted vessels operating in this area and the net cumulative effect would be unchanged.

4.4.4.1.3. Cumulative Effects of Collisions.

ESA-listed birds could strike structures across the North Slope during periods of darkness or inclement weather in nearshore areas. Some facilities are lit in such a manner that may attract and disorient flying birds, resulting in avoidable impacts if improvements to lighting were made. The location of an existing facility or future project is a primary determinant whether some risk of collisions exists. For example, the NSB has proposed to reconstruct and/or relocate the existing airport on Barter Island. This airport services Kaktovik. The project proposes to run a power line to the new sites, which could increase the number of migratory birds killed. As the site is outside the typical distribution of ESA-listed eiders, few impacts to eiders from collisions would be expected. Similarly, there are few communities and no oil or gas infrastructure in coastal areas of the Chukchi Sea. With fewer structures to strike, the risk of collision should be lower in that area.

Oil and gas development in nearshore waters under State jurisdiction could add to collision potential experienced by Steller's and spectacled eiders in the Beaufort Sea region.

Monitoring of bird-strike mortality across the North Slope is infrequent, so the level of mortality cannot be estimated. The FWS maintains a database of reported collisions (USDOI, FWS, 2005). The MMS review of this database indicates the level of mortality to ESA-listed birds appears low or zero.

The Proposed Action could result in an incremental increase in the total number of structures in the area; however, these structures would have proportionately fewer impacts compared to other structures in the project area. Mitigation measures required on existing and future exploration and development activities on OCS leases or surrounding waters are believed to minimize collision mortality to ESA-listed birds associated with OCS oil and gas activity in the region. For example, the Liberty project engineers consulted with MMS and FWS about lighting of the production facility and will implement measures intended to minimize effects on migrating eiders, including the installation of special lights on their sheetpile bulkhead (USDOI, MMS, 2007a). While MMS does not assume that recommendations for the design and implementation of lighting of structures would result in no strikes by ESA-listed birds, both MMS and FWS believe that the lighting protocols will reduce the potential for bird strikes.

Conclusion: Bird collisions resulting from existing and future structures unrelated to OCS activities are ongoing and could result in a minor cumulative effect on listed eiders and other birds. Activities included in the Proposed Action could result in a small contribution to this continued minor cumulative effect on ESA-listed birds.

4.4.4.1.4. Cumulative Effects of Petroleum Spills.

While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect large numbers of birds. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas should be an infrequent occurrence. Particular concern has been expressed over increases in tourism and shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill-prepared to traverse these remote and dangerous areas. Vessels traversing the Chukchi and Beaufort seas during period of ice are more prone to an accident. The ADEC (2007) reported that the highest probability of spills of non-crude products occurs during fuel-transfer operations at the remote villages of the North Slope.

Other sources of petroleum spills include a well blowout (DEIS, Section 1.1.4), but these are modeled as having a low percent chance of occurring and it is improbable that adverse effects to ESA-listed birds from these activities would occur.

The MMS has evaluated the potential for a spill to arise from the Proposed Action. Considering the low probability of a large spill coupled with a variety of other factors that would need to be satisfied to result in take, the MMS has concluded that it is highly unlikely that incidental take of listed eiders will result from oil spills within the action area. However, should any oil spill within the Alaskan Arctic OCS attributable to MMS-authorized activities result in the incidental take of any Steller's or spectacled eider, the MMS will immediately cease all operations responsible for the incidental take pending reinitiation if Section 7 consultation

Conclusion: Ongoing activities unrelated to the Proposed Action are anticipated to result in a negligible cumulative effect on threatened and endangered birds, because petroleum spills are considered infrequent, illegal, or accidental events. However, the greatest source of a spill of non-crude products remains associated with bulk fuel transfer operations at the remote villages of the North Slope.

4.4.4.1.5. Cumulative Effects of Increased Bird Predator Populations.
The dependence by ravens on human-use foods and garbage, combined with the potential increase in nesting sites from existing and future developments, are anticipated to continue and will result in the expansion in the distribution and abundance westward across the North Slope. Only a concerted management program to deny ravens access to artificial food sources and removal of nests or ravens would halt the facilitated expansion of breeding ravens across the North Slope. This is not anticipated to occur in the reasonably foreseeable future and moderate adverse effects to ESA-listed birds are anticipated to continue.

A similar, but lesser, impact occurs from foxes obtaining human-use foods/garbage or denning in sites made suitable from development. While foxes are endemic to the North Slope, densities may be greater due to increased availability of food or den sites, particularly in areas adjacent to the Beaufort Sea.

Mitigation measures imposed on future exploration and development activities on existing future leases or surrounding waters would avoid or minimize adverse effects to ESA-listed birds in the Alaskan Arctic OCS. 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.

A lease stipulation (requiring that new infrastructure would avoid the artificial enhancement of predator populations) recently has been implemented for the Liberty project and is anticipated to be implemented for future developments associated with Federal leases. Implementation and enforcement of a leasing stipulation could be expected to minimize any effects of increased predator populations resulting from Federal actions in the OCS. For this reason, no incidental take of eiders from increased predator populations is anticipated to occur.

Conclusion: Ongoing activities unrelated to the Proposed Action are anticipated to result in a continued minor cumulative effect on threatened and endangered birds from increased bird predator populations. The Proposed Action would have no effect on bird predator populations.

4.4.4.1.6. Cumulative Effects of Increased Subsistence Hunting Activity.
The FWS has made an effort to educate the local hunting public about the plight of spectacled and Steller's eiders and has stated that the prohibition against harvest of these species would be enforced, but some level of shooting mortality continues. 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).

Improved access can increase the range of hunters to areas where ESA-listed eiders could be killed. For example, the NSB has proposed to improve or relocate the existing airport on Barter Island. This airport services Kaktovik. One alternative would construct a 5.4 mi road to a new airport on the mainland. The community has favored this alternative for a number of reasons, including increased access to hunting areas (Hattenberg, Dilley, and Linnell, 2008). Another alternative would add a new road south to a new landfill site. Kaktovik is at the extreme limit of ESA-listed eiders; accidental harvest of ESA-listed eiders should not occur, because they seldom occur there.

There would not be any change in subsistence-hunting activity due to exploration activities on existing leases or surrounding waters. Future production of oil or gas resources on the Alaskan Arctic OCS remains speculative. If development and production were to occur, we assume that a pipeline would carry products to pre-existing infrastructure for transport to processing facilities. The pipeline 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. It is unknown whether increased access would result in an increase in shooting mortality of spectacled or Steller's eiders following the creation of a road along a pipeline. The long-term consequences of this speculative development would be evaluated in future NEPA documents and via formal consultation under the ESA, but at the present time are not anticipated to result in an incidental take of listed eiders.

Subsistence fishing using gill nets continues to be a source of mortality of yellow-billed loons.

Conclusion: Ongoing activities unrelated to the Proposed Action are anticipated to result in a continued major cumulative effect to threatened and endangered birds, particularly the Steller's eider. Exploration activities in the Alaskan Arctic OCS would have no cumulative effect on the subsistence harvest activities of ESA-listed birds.

4.4.4.1.7. Cumulative Effects of Habitat Loss.

Existing human development in coastal areas of the Chukchi and Beaufort seas is relatively sparse and limited to several small communities that include Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik. Development likely will occur in the future, and a corresponding amount of eider nesting habitat will be lost. For example, the Arctic Slope Native Association applied for a Section 404 permit to place gravel fill in about 10 acres of wetlands at Barrow (U.S. Army Corps of Engineers, 2007). Similarly, the State of Alaska is managing a project to fill another 19 acres of wetland habitats to expand the Barrow Airport (U.S. Army Corps of Engineers, 2006). Secondary effects from the zone of influence around new or expanded developments also would result in habitat loss for ESA-listed eiders and yellow-billed loons.

Existing industrial developments (Kuparuk and Prudhoe Bay fields) are east of Teshekpuk Lake (DEIS, Section 3.1). Continued development likely will occur in and around these sites, and a corresponding amount of eider nesting habitat will be lost. Secondary effects from the zone of influence around new or expanded developments also would result in habitat loss. For example, in April 2008, BPXA applied to the U.S. Army Corps of Engineers for Section 404 permits to fill over 28 acres of wetlands "to support placement of infrastructure for oil and gas development" or similar project (U.S. Army Corps of Engineers, 2008). Secondary impacts to nesting birds could be smaller due to existing developments nearby. The project sites are within the range of ESA-listed eiders and candidate birds.

Existing human development in coastal areas of the Chukchi and Beaufort seas is relatively sparse and limited to several small communities that include Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik. Development likely will occur in the future, and a corresponding amount of eider-nesting habitat will be lost. For example, the Arctic Slope Native Association applied for a Section 404 permit to place gravel fill in about 10 acres of wetlands at Barrow (U.S. Army Corps of Engineers, 2007). Similarly, the State of Alaska is managing a project to fill another 19 acres of wetland habitats to expand

the Barrow Airport (U.S. Army Corps of Engineers, 2006). Secondary effects from the zone of influence around new or expanded developments would also result in habitat loss for ESA-listed eiders.

Oil and gas exploration or development in nearshore waters under State jurisdiction could add to future loss of Steller's and spectacled eider habitat in the Beaufort Sea region, but certain aspects of these actions would require Federal permits that would require Section 7 consultation under the ESA, which likely would result in minimizing (but not avoid) adverse effects of habitat loss.

There would not be any permanent loss or alteration of bird habitat during exploration and delineation activities on existing or future OCS leases or surrounding waters. Small amounts of temporary habitat loss of Steller's and spectacled eider migration habitats could occur from drilling exploration or delineation wells into the seafloor.

Based on sales-specific probabilities, future production of oil or gas resources from the Beaufort Sea OCS could occur (Section 4.4.1.6.2.3.2.4). If development and production were to occur, facilities would be constructed to extract and transport product to existing processing facilities. Permanent habitat loss could occur if production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure) are located in areas used by Steller's and spectacled eiders. Indirect habitat losses could result from eiders, murrelets, and yellow-billed loons not using habitats near sites of industrial activity. Development from the Chukchi Sea OCS is not reasonable foreseeable.

Post-breeding spectacled eiders molt and replenish/build energy reserves in preparation for migration to the wintering area and winter survival in the Bering Sea. Biologists concur that eiders must make use of high-energy foods to support these physiologically demanding activities. The loss of seafloor habitats due to exploration or delineation drilling cannot be quantified at this time but could be in important molt migration or staging areas. Staging areas for Steller's and spectacled eiders have not been clearly identified but could be widespread across offshore areas. The importance of these areas relative to the timing of molt, survival during the molting period, and condition after molting is unknown; however, the availability and quality of key resources in those areas during the prolonged migration period ultimately may influence the survival of the spectacled eiders (Petersen, Larned, and Douglas, 1999). No critical habitat for ESA-listed birds has been designated in the Beaufort Sea.

Conclusion: Ongoing industrial and community activities, unrelated to the Alaskan Arctic OCS, are anticipated to result in a continued minor cumulative effect on ESA-listed bird habitats because of annual destruction of eider and loon breeding and brood-rearing habitats. Exploration activities under the Proposed Action are not anticipated to affect threatened and endangered bird habitats, whereas hypothetical OCS oil and gas development may necessitate facilities that could eliminate eider and loon breeding and brood-rearing habitats.

4.4.4.1.8. Cumulative Effects of Seismic Airgun Noise.

Seismic activities are used to locate and delineate potential oil and gas resources. Most seismic activity on land is done during the winter when ESA-listed birds are absent. Offshore surveys on submerged State and Federal lands are conducted by vessels during the open-water period. The State of Alaska is considering leasing additional State-owned tide- and submerged lands lying between the Canadian border and Point Barrow. Oil and gas development in nearshore waters under State jurisdiction could add to seismic disturbance experienced by Steller's and spectacled eiders in the Beaufort Sea region. Important mitigation measures that likely would be imposed to protect ESA-listed birds are listed in Appendix 1.

Existing and future Federal leases in the OCS lands of the Chukchi and Beaufort seas, and it is reasonable to expect leaseholders and others to investigate the potential for oil or gas production in the future. Shell

Offshore, Inc., for example, likely will continue to complete seismic surveys and well cellars in advance of exploration drilling on certain existing Beaufort Sea leases (USDOI, MMS 2007b). Similar seismic activities are anticipated for other planned development, such as the Liberty Project (USDOI, MMS, 2007c). Additional seismic or exploration work likely would be proposed in the future for existing or future leases in Alaskan Arctic OCS. Exploratory/delineation drilling, seismic work, and related support activities generally would occur primarily during the ice-free, open-water period.

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

4.4.4.1.9. Cumulative Effects of Changes in the Physical Environment.
Section 4.4.1.1.9 briefly described likely ongoing effects from changes in oceanographic processes and sea-ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise. These changes in the physical environment may affect marine and coastal bird populations, including species protected by the ESA.

Some of these expected changes could benefit coastal birds using habitats on the ACP, at least initially. An expansion of more productive wetland habitats could provide additional nesting sites for several species and boost the abundance and distribution of aquatic plants, insects, or fish important to many bird species. These benefits to birds would be expected to decline over time as the wetlands and lakes disappear. The exact timeframes for these changes are not determined and likely vary across the North Slope.

Climatic change could have stochastic or habitat effects on many species that may surpass the impacts of other activities; however, as previously stated, the implications of climate change on threatened and endangered birds are impossible to predict with any precision. For purposes of analysis, we assume most of the obvious trends are anticipated to continue. We considered these trends in determining the effects of the Proposed Action.

Summary. Continued climate change is anticipated to result in a major level of effect on ESA-listed birds. These long-term trends are outside the influence of the Proposed Action.

Species-Specific Effects.
The following analysis describes the anticipated cumulative effects that could occur to individual species of ESA-listed birds if MMS continues to authorize activities on the Alaskan Arctic OCS and holds future lease sales in the Beaufort or Chukchi seas under the current 5-year program.

Cumulative Effects on the Steller's Eider. Unrestricted vessel and low-level aircraft traffic could continue to be a chronic source of disturbance, especially to Steller's eiders in the spring lead system. Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities on the Alaskan Arctic OCS would be achieved, because vessels and aircraft associated with these activities are expected to be managed to avoid conflicts with eiders.

Wetland fills from community and industry infrastructure development could immediately eliminate Steller's eider habitat, compared to the more gradual habitat changes expected to result from climate change. Collisions with existing or future developments at these and other sites could continue to present a collision hazard and small numbers of Steller's eiders could be killed, resulting in a minor cumulative effect to Steller's eiders. While shooting mortality and maritime fuel spills remain the greatest threat to eiders in the region, the Proposed Action would not affect these threats. No population-level effect to the Steller's eider is anticipated from the Proposed Action.

Hypothetical Production in the Chukchi Sea: The overall effects of potential production (considered speculative) include periodic interruption of post-breeding Steller's eiders migrating in nearshore coastal areas. Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would not result in a loss of Steller's eider nesting habitat. Despite mitigation measures to minimize disturbance from vessel and low-level aircraft traffic, a production platform in the Ledyard Bay Critical Habitat Area could displace some Steller's eiders from important spring staging areas for several decades and place sources of large or chronic spills in closest proximity to migrating Steller's eiders when they are most vulnerable. The level of incidental take for hypothetical development scenarios associated with the Proposed Action presents the greatest potential for a moderate effect on Steller's eiders.

Hypothetical Production in the Beaufort Sea: The overall effects of potential production under the Proposed Action include periodic interruption of post-breeding Steller's eiders migrating in nearshore coastal areas. Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would result in a loss of eider nesting habitat and cause eiders nesting outside a zone of influence around these sites. Overall, these zones of influence associated with development facilities could have a collective areal extent of 3.45 km^2 (855 ac) in eider nesting habitats, resulting in an estimated indirect take of two Steller's eiders (DEIS, Table 4.4.1.6.2-1).

Cumulative Effects on the Spectacled Eider. Unrestricted vessel and low-level aircraft traffic could continue to be a chronic source of disturbance, especially to spectacled eiders in the spring lead system. Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities on the OCS could be achieved, because vessels and aircraft associated with these activities are expected to be managed to avoid conflicts with eiders. For example, vessels would not disturb molting spectacled eiders because they would not be permitted in the Ledyard Bay Critical Habitat Area after July 1 of each year, even if they were transiting to or from the Beaufort Sea.

Wetland fills from community and industry infrastructure development could immediately eliminate spectacled eider habitat, compared to the more gradual habitat changes expected to result from climate change. Collisions with existing or future developments at these and other sites could continue to present a collision hazard, and small numbers of spectacled eiders are expected to be killed, resulting in a minor cumulative effect to spectacled eiders. Maritime fuel spills remain the greatest threat to eiders in the region, the Proposed Action would not affect this threat.

Hypothetical Production in the Chukchi Sea: The overall effects of potential production (considered speculative) include periodic interruption of post-breeding and molting spectacled eiders migrating in nearshore coastal areas, including the Ledyard Bay Critical Habitat Area. Despite mitigation measures to minimize disturbance from vessel and low-level aircraft traffic, a production platform in the Ledyard Bay Critical Habitat Area could displace large numbers of spectacled eiders from important molting areas for several decades and place sources of large or chronic spills in closest proximity to migrating or molting eiders when they are most vulnerable. Eventually, the abandonment of any and all surface and seafloor facilities would be removed, so no permanent adverse modification of critical habitat would occur.

Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would result in a loss of eider nesting habitat and cause eiders nesting outside a zone of influence around these sites. The direct impact to eider nesting habitats would be 17.37 km^2 (4,291 acres), displacing an estimated 19 spectacled eiders. The zone of secondary influence associated with development facilities could have a collective areal extent of 193.13 km^2 (48,464 acres) in eider nesting habitats, resulting in an estimated indirect take of 216 spectacled eiders (DEIS, Table 4.5.1.6.2-1). The level of incidental take for hypothetical development scenarios associated with the Proposed Action presents the potential for a major, population-level of effect on spectacled eiders.

Hypothetical Production in the Beaufort Sea: The overall effects of potential production include periodic interruption of post-breeding and molting spectacled eiders migrating in nearshore coastal areas. Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would result in a loss of eider nesting habitat and cause eiders to nest outside a zone of influence around these sites. Overall, these zones of influence associated with development facilities could have a collective areal extent of 3.45 km^2 (845 ac) in eider nesting habitats, resulting in an estimated indirect take of 37 spectacled eiders (DEIS, Table 4.4.1.6.2-1).

Cumulative Effects on the Kittlitz's Murrelet. The Kittlitz's murrelet could continue to be subjected to a chronic source of disturbance from unrestricted vessel and low-level aircraft traffic in nearshore areas of the Chukchi Sea. Similarly, murrelets would be prone to spill effects that could arise from maritime accidents or bulk fuel transfers.

There may be an incremental increase in vessel and aircraft traffic associated with future OCS activities under the proposed Action. Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities on the OCS could be achieved, because vessels and aircraft associated with these activities are expected to be managed to avoid conflicts with eiders. For example, vessels would not disturb any Kittlitz's murrelets in the Ledyard Bay CHA, because these vessels would not be permitted in that area after July 1 of each year, even if they were transiting to or from the Beaufort Sea. Most mitigation or conservation measures originally developed specifically to benefit threatened eiders would benefit murrelets as well.

Chukchi Sea: Relatively large numbers of Kittlitz's murrelet have recently been reported just west of Barrow. Foraging Kittlitz's murrelets could be periodically disturbed by existing and future vessel and low-level aircraft traffic. Mortality of Kittlitz's murrelets could occur from future maritime accidents or bulk fuel deliveries, but the number affected depends on the time and location of the spills. Should oil or gas production occur in the Chukchi Sea OCS, chronic low-volume spills or a large platform or pipeline spill could result in the death of some Kittlitz's murrelets, but the number affected depends on the time and location of the spills. The Proposed Action is anticipated to have no more than a minor level of effect on Kittlitz's murrelets in the Chukchi Sea.

Beaufort Sea: The Kittlitz's murrelet has not been documented to occur in the Beaufort Sea, but large numbers recently have been reported just west of Barrow, and it appears reasonable that some occur east of Barrow. If some Kittlitz's murrelets occurred in the Beaufort Sea, they could be disturbed periodically when foraging. The Proposed Action is not anticipated to affect the Kittlitz's murrelet population in the Beaufort Sea because, if they occur there, they are there in very low numbers.

Cumulative Effects on the Yellow-billed Loon. The yellow-billed loon could continue to be subjected to a chronic source of disturbance from unrestricted vessel and low-level aircraft traffic in nearshore marine areas of the Chukchi and Beaufort seas. Wetland fills from community and industry infrastructure development could rapidly eliminate yellow-billed loon habitat, compared to the more gradual habitat changes expected to result from climate change. Similarly, yellow-billed loons would be prone to spill effects that could arise from maritime accidents or bulk fuel transfers to North Slope communities, but the number affected depends on the time and location of the spills.

There may be an incremental increase in vessel and aircraft traffic associated with future OCS activities under the Proposed Action. Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities on the Alaskan Arctic OCS could be achieved, because vessels and aircraft associated with these activities are expected to be managed to avoid conflicts with eiders. For example, vessels would not disturb any yellow-billed loons in the Ledyard Bay CHA, because these vessels would not be permitted in that area after July 1 of each year, even if they were transiting to or from the Beaufort Sea. Most mitigation or conservation measures originally developed specifically to benefit threatened eiders would benefit yellow-billed loons as well.

Should future oil or gas production occur in the Alaskan Arctic OCS, chronic low-volume spills or a large platform or pipeline spill could result in the death of some yellow-billed loons, but the number affected depends on the time and location of the spills. The Proposed Action is anticipated to have no more than a minor level of effect on yellow-billed loons in the Chukchi Sea.

4.4.4.2. Cumulative Effects to the Polar Bear from the Proposed Action.

Ongoing trends in the decrease of sea ice extent and formation in combination with other climactic trends pose the greatest threat to the continued presence of the polar bear in Alaska. Other more minor impact producing factors include vessel traffic; air and terrestrial traffic; subsistence hunting; increases in the oil and gas industrial footprint from onshore and offshore State leases, onshore BLM leases and offshore MMS leases; and the potential for oil spills.

Polar bear distribution may be changing in response to changes in sea ice. Polar bears may be spending more time on shore fasting or on sea ice fasting. Reproductive success and overall body condition may also be declining. These changes may make the polar bear more susceptible to detrimental effects from other impacting factors. The following measures may help to reduce additional adverse impacts to polar bears. Continuing and improving mitigation measures to avoid disturbing bears that may already be energetically stressed may help to reduce any additional impacts from other human activities. Identifying and avoiding adversely modifying critical habitat, particularly denning habitat and areas where bears congregate while waiting for the sea ice to form, may also reduce impacts from anthropogenic activities. Continuing to enhance safety measures that avoid or reduce the potential for oil spills, and to explore new and more effective clean up technologies may reduce the potential for impacts from spill events. Continuing to monitor the population and to reduce the subsistence take as necessary as the population declines in order to remain at or below sustainable levels.

Conclusion:

Beaufort Sea: Current levels of vessel, aircraft and motorized vehicle traffic from MMS-related or other activities are not expected to have more than negligible impacts on polar bears in the Alaskan Arctic. Seismic activities, habitat loss from industry or village footprints and small petroleum spills from MMS-related or other activities are not expected to have more than minor impacts to polar bears. A large petroleum spill from MMS-related activities is considered a very unlikely event, and as such, is not expected to have more than minor impacts on polar bears.

Impacts from local community travel and subsistence activities are expected to continue at current levels. Disturbances to polar bears in nearshore areas from vessel, snow machine, and low-flying aircraft traffic unrelated to MMS-authorized activities on the OCS, as well as from regulated OCS activities, would continue to have some minor effects on polar bears. MMS-authorized activities associated with existing or future OCS leases in the Beaufort Sea under the Proposed Action are not likely to adversely affect the polar bear.

Chukchi Sea: There would be a negligible level of cumulative effects from seismic surveys and petroleum spills; vessel presence and noise and aircraft presence and noise. There could be a moderate level of effect from subsistence hunting and other forms of take not related to OCS activities. MMS-authorized activities associated with existing or future OCS leases in the Chukchi Sea under the Proposed Action are not likely to adversely affect the polar bear.

Overall, impacts to polar bears are greatest from ongoing climate changes, particularly sea-ice reductions and potential changes in prey availability. The Proposed Action, however, has no direct influence on these trends. Documented impacts to polar bears to date in the Alaskan Arctic OCS by the oil and gas industry appear minimal. Close cooperation between MMS, FWS, and OCS operators will help to ensure that the level of effect does not increase. We conclude that the Proposed Action, if properly mitigated through the MMPA LOA process, is not likely to adversely affect the polar bear. The Proposed Action, in concert with other non-federal activities in the Alaskan Arctic would likely have minor effects on polar bears, primarily because those sources of harm are already at a minor level of effect.

4.4.4.2.1. Cumulative Effects of Vessel Presence and Noise.
Frequent traffic associated with freight, intercommunity travel, research studies, subsistence hunting and oil and gas operations likely affect some bears, however, polar bears generally remain offshore in the pack ice, or onshore during the open-water season and few bears are likely to be affected by vessel traffic during the open water season. Any adverse effects to polar bears, primarily through temporary displacement, from these activities are anticipated to continue.

Existing information indicates an increasing amount of vessel traffic, particularly in tourism and research (icebreaker cruises) vessels in the Arctic, such as those seeking to explore and study arctic regions. There is a high level of interest in using the Northwest Passage as a shipping route to decrease the distance ships would have to travel between the Pacific and the Atlantic oceans. Increasing military and US Coast Guard activities also are anticipated. An increase in icebreaker traffic could disturb small numbers of polar bears and potentially disrupt movement patterns or temporarily displace some bears from preferred foraging areas.

Mitigation measures required for oil and gas exploration and development activities avoid or minimize adverse effects to polar bears in the Beaufort and Chukchi seas by requiring that marine mammal observers be onboard, requiring the shut down of seismic operations if marine mammals are observed within the 180/190 dB zone and avoiding approaching marine mammals and avoiding spring lead systems. Existing and future OCS actions under the Proposed Action could contribute a small incremental increase in the total number of vessels operating in the Alaskan Arctic; however, vessel presence and noise are anticipated to result in negligible impacts to polar bears.

4.4.4.2.2. Cumulative Effects of Motorized Vehicle Presence and Noise.
All aircraft are advised to maintain a minimum of 500 ft above ground level by federal aviation regulations. OCS-related aircraft operations are required to maintain 1,500 ft AGL minimum as long as it is safe to do so. In addition, airborne hunting laws make it illegal to haze or harass animals from any aircraft. Both state game regulations and the MMPA make it illegal to haze or harass polar bears from any vehicle, snowmachine or all-terrain vehicle. In spite of these restrictions, some disturbance to polar bears in nearshore areas may occur and would continue to have a minor effect on polar bears.

Existing and future OCS actions under the Proposed Action could contribute to an incremental increase in the total number of aircraft and motorized vehicles operating in the Alaskan Arctic. OCS-related aircraft and motorized vehicles have effective mitigation requirements and would contribute a negligible amount to the overall minor impact to polar bears arising from motorized activities in the Alaskan Arctic

4.4.4.2.3. Cumulative Effects of Subsistence and other Harvest.
The level of illegal harvest in Russia, in combination with legal hunting may have a major impact on the Chukchi Sea polar bear population. Subsistence hunting and defense of life take of the Southern Beaufort Sea population of polar bears in Alaska is currently below sustainable levels (40 bears/year) and is anticipated to remain so. The Proposed Action would not influence the level of take in Alaska.

4.4.4.2.4. Cumulative Effects of Petroleum Spills.

Spills are accidental or illegal events that can arise from a variety of sources. While spills can occur on land or in the marine environment, spills on or near barrier islands in fall or winter or in the marine environment have the greatest potential to affect polar bears.

It is difficult to estimate the potential for chronic small spills or a large spill to originate from private, commercial, or State sources within the Chukchi or Beaufort seas. Sources of petroleum spills include a well blowout or other contamination from oil and gas exploration or development on State lease lands in the Beaufort Sea or on lease lands in the Canadian Beaufort. These are modeled as having a low chance of occurring and, therefore, are unlikely to have adverse effects on polar bears. A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4 of the DEIS.

According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas would be an infrequent occurrence. Particular concern has been expressed over increases in tourism and shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill-prepared to traverse these remote and dangerous areas. Vessels traversing the Chukchi and Beaufort seas during period of ice may be more prone to an accident. While small spills of refined petroleum products from all sources of marine and land transportation sources are expected to continue, the ADEC (2007) reports that the highest probability of spills of non-crude products occurs during fuel transfer operations at the remote villages of the North Slope.

Conclusion: Petroleum spills from OCS or non-OCS activities could adversely affect polar bears in the Alaskan Arctic. To date, small spills have not impacted polar bears in the Arctic, however increasing vessel traffic in general and bulk fuel deliveries in particular, appear to present some danger of an oil spill to polar bears in the Alaskan Arctic.

4.4.4.2.5. Cumulative Effects of Habitat Loss and Degradation.

Existing human development in coastal areas of the Chukchi and Beaufort seas is limited to several small communities that include Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik. Development from village expansion, NPR-A development, and other sources likely will occur in the future, and it is possible that some amount of polar bear denning habitat may be lost or altered. Provided that these developments are small and that appropriate mitigation is adequate, a minor level of effect is anticipated.

<u>Beaufort Sea:</u> Incremental increases in infrastructure for community and industrial development are anticipated to result in the loss and degradation of polar bear denning and other habitats. Oil and gas exploration or development in nearshore waters under State jurisdiction could add to future loss of polar bear habitat in the Beaufort Sea region. Some aspects of these non-federal actions nevertheless would require Federal permits requiring Section 7 consultation under the ESA, which likely would result in minimizing adverse effects of habitat loss.

Currently, the only OCS production in the Beaufort Sea is the Northstar unit operated by BP and located approximately 6 miles offshore of the Point Storkerson area. Northstar is a self-contained offshore development/production facility located on a gravel island in 39 feet of water. Northstar was constructed on Seal Island, which was constructed by Shell Oil Company for exploration purposes in the 1980's. To date, Northstar has had negligible impacts to polar bears.

One offshore development currently considered reasonably foreseeable in the Beaufort Sea OCS is Liberty. The Liberty development is expected to be an extended-reach drilling project linked to facilities onshore and to Endicott. This development will not result in the loss of any habitat at the Liberty site. The Endicott site and onshore facilities may be expanded and have a slightly increased footprint. This project is expected to have minor or negligible impacts on polar bears, and will not adversely impact the population. For further information on the Liberty development, see the Liberty Development Project EIA, July 2007. Reasonably foreseeable future developments in State waters in the Beaufort Sea include Thetis Island, Sandpiper, and others (see DEIS, Table 3.1.1-1).

Chukchi Sea: We expect some loss and degradation of polar bear habitat to result from future non-federal actions, depending upon the location of future developments and potential changes in polar bears' use of the nearshore environment due to climate change. Incremental increases in infrastructure for community and industrial development are anticipated to result in minor impacts on polar bear denning and other habitat. Oil and gas exploration or development in nearshore waters under State jurisdiction could add to future loss of polar bear habitat in the Chukchi Sea, however no state lease sales are currently being considered.

Conclusion: The combination of habitat loss and degradation from the Proposed Action with effects from other sources in the Alaskan Arctic are anticipated to have a minor effect on polar bears. Critical habitat, as defined by the ESA, has not yet been designated for the polar bear. At this time, FWS is in the process of determining critical habitat for the polar bear. Once this process is complete, additional protections for these critical habitat areas may be instituted and direct habitat loss and degradation could be reduced.

4.4.4.2.6. Cumulative Effects of Seismic Noise.

While MMS-authorized activities on the Alaskan Arctic OCS are the greatest source of seismic activity, ongoing exploration and future activities are occurring in the Beaufort Sea on areas leased by the State of Alaska and are anticipated to continue. Similarly, terrestrial seismic surveys may take place on lands leased by the State or within the NPR-A along the Chukchi Sea coast. While MMS actions would likely result in an incremental increase in sources of potential impacts, required mitigation measures could limit these impacts. The MMPA requires that impacts to marine mammals must be negligible or the proposed activities will not be permitted or authorized.

Seismic surveys and exploration drilling are anticipated to continue near existing levels due to a limited number of suitable or specialized vessels for conducting these activities, or they could increase if the operators secure additional vessels and equipment. The NMFS and/or FWS may choose to limit the number of active seismic operations or to limit the operating area in order to decrease impacts to marine mammals, including polar bears. Currently, the NMFS Arctic Region Biological Opinion limits seismic operations to a maximum of 6 in both seas. If current equipment constraints hold, no more than two drill rigs could operate in the Beaufort Sea or Chukchi Sea at any one time. Similarly, no more than six seismic-surveying activities could be completed during a season simultaneously in the Chukchi Sea or Beaufort Sea.

Conclusion: Current mitigation measures require that operators stop operations if a polar bear enters within range of 190dB of sound. On-ice operations are required to search for dens before the onset of seismic work, and generally must avoid dens by 1 mi. These mitigation measures effectively minimize impacts to polar bears and a negligible or minor effect to polar bears is anticipated.

4.4.4.2.7. Cumulative Effects of Changes in the Physical Environment.

Cumulative impacts to polar bears are greatest from ongoing climate changes, especially sea-ice reduction and potential changes in prey availability. Habitat loss due to continued changes in sea-ice extent and stability are expected to have major effects on the polar bear. Some coastal denning and resting habitat may also be lost due to increases in erosion from more frequent storm events, which may dramatically change the shoreline. Snow cover over tundra and drifts along shorelines are becoming less deep, which may make it more difficult for bears to build dens, or may result in dens melting and collapsing earlier in spring, forcing females with cubs to leave den sites prematurely.

If current trends continue as predicted, polar bears may spend more time onshore, or spend more time on sea ice that has retreated over deepwater not suitable for foraging. There may be declines in abundance and availability of ringed and other ice seals as prey items. Current declines in fitness (as measured by weight, fat reserves, and fecundity) also may continue.

Conclusion: We anticipate that these ongoing trends will have major impacts on the polar bear, and that these trends are likely to adversely affect the polar bear. The Proposed Action, however, has no direct influence on these trends.

4.4.5. Determination of Effects

4.4.5.1. Threatened and Endangered Birds

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:

- The Proposed Action could result in activities in new areas that *may affect* listed eiders in the Chukchi Sea and Beaufort Sea (the Alaskan Arctic). 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 eiders could still be killed by their collision with exploration structures and these mortalities are *likely to adversely affect* Steller's and spectacled eiders. This conclusion is based on the MMS considering potential levels of collision mortality to not be discountable or insignificant as defined by the ESA.
- The Proposed Action could result in long-term (20+ years) adverse effects to the Ledyard Bay Critical Habitat Area, but these activities *would not* result in a permanent adverse modification of this designated critical habitat, because any production facilities eventually would be removed or otherwise not remain above the seafloor in the critical habitat area. Furthermore, the Ledyard Bay Critical habitat Area has been deferred from lease sale areas in the past and could be deferred in the future.
- The Proposed Action could present new sources of disturbance that could affect Kittlitz's murrelets and yellow-billed loons, particularly in the Chukchi Sea. Comprehensive mitigation or conservation measures will avoid or minimize potential impacts and the Proposed Action is *not likely to adversely affect* the Kittlitz's murrelet or the yellow-billed loon in the action area.

4.4.5.2 Polar Bear

It is determined through this analysis that the Proposed Action likely would have the following effect, as described by the ESA, on the polar bear. Critical habitat has not been designated for the polar bear.

- The Proposed Action could result in activities in new areas that *may affect* the polar bear in the Chukchi Sea and Beaufort Sea (the Alaskan Arctic). Comprehensive mitigation measures will avoid or minimize potential adverse impacts to polar bears, but long-term disturbance could still occur in certain habitats. These effects are *not likely to adversely affect* the polar bear because these effects are considered discountable or insignificant as defined by the ESA.

Additional Literature not included in the DEIS:

Federal Register. 2008. Migratory Bird Subsistence Harvest in Alaska; Harvest Regulations for Migratory Birds in Alaska During the 2009 Season. 50 CFR Part 92. *Federal Register* 73(244):76994-76999.

Federal Register. March 25, 2009. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Yellow-Billed Loon as Threatened or Endangered; Proposed Rules. 74:12931-12968.

Rizzolo, D.J. and J.A. Schmutz. 2008. Monitoring marine birds of concern in the eastern Chukchi nearshore area (loons). Annual Report 2008 for Minerals Management Service, Alaska Region OCS. Alaska Science Center, U.S. Geological Survey. 37 pp.

North, M.R. 1994. Yellow-billed Loon, No. 121. The Birds of North America. A. Poole and F. Gill, eds. American Ornithologists' Union and Academy of Natural Sciences.

Wang, J., J. Zhang, E. Watanabe, M. Ikeda, K. Mizobata, J.E. Walsh, X.Bai, and B. Wu. 2009. Is the Dipole Anomaly a major driver to record lows in Arctic summer sea ice extent? Geophysical Research Letters, Vol. 36, L05706, doi:10.1029/2008GL036706.

Appendix 1: Mitigation Measures for the Proposed Action

Mitigation Measures

1. Existing Mitigation Measures

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 (USDOI, 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 LOAs or IHAs 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 LOAs must be applied for and in place or IHAs 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 (ITAs) 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 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 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 LOAs and IHAs 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 sonar, 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 OSRPs. 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 OSRPs. 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 OSRPs 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 OSRPs. 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 (USDOI, 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 (USDOI, 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 walruses 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 USDOI, 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 OSCPs. 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 OSCPs 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-listed 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 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.

2. Mitigation Measures for Future Sales under 5-Year Program

The following mitigation measures are proposed for future sales under the current MMS 5-Year Program in the Beaufort and Chukchi seas. Some of the mitigation measures were developed over recent years for lease sales and for the continuing program in the Alaska OCS.

2.1. Stipulations.

Stipulation No. 1 – Orientation Program.

The lessee shall include with any Exploration Plan (EP) or Development and Production Plan (DPP) submitted under 30 CFR 250.212 and 250.242, respectively, an overview of a proposed orientation training program for all personnel (including personnel of the lessee's agents, contractors, and subcontractors) involved in on-site exploration, development, production, and support activities.

The orientation program shall inform on-site personnel about environmental, biological, social, and cultural concerns that relate to oil and gas activities on the OCS and adjacent areas. The program shall address the importance of not disturbing biological resources and habitats and include an explanation of "take" definitions under the ESA and MMPA. The program shall include guidance about restrictions on approaching marine mammals and how to avoid disturbance of marine mammals. The program shall be designed to increase the awareness and understanding of industry personnel to local community values, customs, and lifestyles, including an overview of the Iñupiaq culture and the importance of subsistence hunting and sharing practices. The orientation program shall include information concerning avoidance of conflicts with subsistence activities. The program shall address the importance of not disturbing archaeological, cultural, and historic resources and provide guidance on how to avoid disturbance of these resources.

All personnel involved in on-site exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel overseeing such activities must complete the orientation training program before beginning onsite work and annually thereafter. Evidence of completion of the orientation program by individuals employed by the lessee is subject to MMS onsite inspection.

Upon request from the Regional Supervisor/Field Operations (RS/FO), orientation material shall be made available for MMS review. The RS/FO may require materials to be modified if MMS review determines the materials do not adequately cover the environmental, biological, social, and cultural concerns of the area.

Summary of the Effectiveness. This stipulation requires that all personnel involved in oil and gas activities on the OCS and adjacent areas in support of this OCS leases be made aware of the unique environmental, social, and cultural values of the local Iñupiat residents and their environment. This stipulation should help avoid disturbance, damage, or destruction of environmental, cultural, and archaeological resources through awareness and understanding of historical and cultural values and environmental protection laws. This stipulation would help minimize potential conflicts between subsistence hunting and gathering activities and oil and gas activities. The extent of mitigation offered by this stipulation is difficult to measure directly or indirectly. This orientation program educates personnel on minimizing potential disturbances to polar bears.

Stipulation No. 2 – Measures Required to Minimize Effects on Species Listed under the Endangered Species Act.

Operations conducted in support of exploration and development activities on this OCS lease are required to adhere to the conditions of the most recent Biological Opinions issued by the Fish and Wildlife Service and the National Marine Fisheries Service.

Summary of the Effectiveness. The Biological Opinions issued by the FWS and the NMFS often specify measures necessary and appropriate to minimize potential adverse impacts to protected species. This stipulation is expected to reduce potential effects of OCS exploration and development on protected species. For example, this stipulation is expected to reduce the potential for spectacled and Steller's eiders to strike structures, which would lessen the potential effect of OCS exploration and development on these species.

Stipulation 2 states that operations authorized or permitted by MMS will be required to adhere to conditions set forth in the most recent Biological Opinion issued by the FWS on polar bears. The BO is expected to outline specific conservation measures required to decrease the potential for impacts on the polar bear population. These may be in the form of RPMs (Reasonable and Prudent Measures) or Terms and Conditions (T & Cs). Many of these mitigation measures may already be in place through the MMPA/LOA process. Additional protective measures for habitats determined by the FWS to be critical habitat under the ESA may be enforced. FWS anticipates that the process of identifying and designating critical habitat for the polar bear may be completed in 2010.

Stipulation No. 3 (Beaufort Sea OCS leases only) – Permanent Facility Siting in the Vicinity Seaward of Cross Island.

Permanent sea-surface production facilities within a 10-mi radius seaward of Cross Island are prohibited unless the lessee demonstrates to the satisfaction of the Regional Director that the development will not preclude reasonable subsistence access to whales. This stipulation applies to any OCS lease on the blocks listed below.

OPD; NR 06-03 Beechey Point; Blocks: 6415A; 6416A; 6417A; 6418A; 6419A; 6464B, D, F; 6465A, B; 6466A, B; 6467A, B; 6468A, B; 6469A, B; 6470A; 6514B, D, E, F, H; 6515B, C, D, E; 6516B, C, F; 6517B, D; 6518B; 6519A, B; 6520A; 6521A; 6565B; 6566B, E; 6568B; 6569A, B; 6570A, B; 6571A, C; 6618B, C, E; 6619A, B, C; 6620B, D; 6621B; 6670B.

Summary of the Effectiveness. This stipulation prohibits permanent sea-surface facilities within a 10-mi radius seaward of Cross Island, unless the lessee demonstrates to the satisfaction of the MMS Regional Director that such a facility would not preclude reasonable subsistence access. This stipulation is expected to reduce the potential conflict between subsistence-hunting activities and oil and gas development and operational activities within the key subsistence areas seaward of Cross Island, where the community of Nuiqsut's subsistence whaling takes place. This stipulation also could reduce the potential that noise from a facility in this area could deflect the bowhead whales farther offshore.

Stipulation 3 requires that no permanent facilities be located within 10 miles seaward of Cross Island. Cross Island is a very important site for polar bears aggregating on shore while waiting for freeze up and access to the offshore ice environment. This stipulation would protect a portion of that area and decrease the possibility that MMS authorized activities in the vicinity would impact polar bear movements.
This stipulation could prevent the development and production of oil and gas resources (if they exist and are discovered during exploration), if it is determined by the Regional Director that the proposed facilities would preclude reasonable access to subsistence bowhead whales.

2.3. Notices to Lessees. The objectives of several of the lease stipulations evaluated in the previous Arctic OCS lease sale EISs are more appropriately addressed via NTLs (see Section 2.2.1 for discussion). The provisions of these stipulations are required through existing MMS operating regulations. The proposed new NTLs inform lease owners/operators that they must meet the provisions of the regulations and how they are to operate under the applicable regulations. The proposed new NTLs are summarized below. The full text of the proposed NTLs is provided in Appendix F.

NTL No. 08-A01 Protection of Biological Resources. This NTL provides guidance to the lease owner/operator related to protection of previously unidentified biological populations or habitats that may be discovered during the conduct of any operations on a lease. It is issued to clarify and interpret the requirements contained in regulations for protection of seafloor resources. The lease owner/operator shall make reasonable efforts to protect the newly discovered biological resource from effects from operations until the RS/FO instructs the lease owner/operator on what measures, if any, are required to avoid or minimize adverse effects to the biological resource pursuant to 30 CFR 250.201 and 30 CFR 250.202.

NTL No. 08-A02 Protection Subsistence Whaling and Other Marine Mammal Subsistence-Harvest Activities. This NTL provides guidance to the lease owner/operator related to protection of subsistence-harvest of whales and other marine mammals during the conduct of any operations on a lease. It is issued to clarify and interpret the requirements contained in regulations for protection of subsistence activities. The MMS operating regulations at 30 CFR 250.202 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. Operating regulations at 30 CFR 250.209 state that ancillary activities also must comply with the performance standards of 30 CFR 250.202. Operating regulations at 30 CFR 250.221(b), 30 CFR 250.223, 30 CFR 250.252(b), and 30 CFR 250.254 require OCS lease owners/operators to provide information on how they will conduct their proposed activities in a manner consistent with the provisions of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). Exploration, development, production, and support activities, including ancillary activities, shall be conducted in a manner that prevents reasonably foreseeable conflicts between the lease owner/operator activities and subsistence activities (including, but not limited to, bowhead whale and other marine mammal subsistence hunting). If proposed activities have the potential to adversely affect subsistence-harvest activities, MMS will require EPs or DPPs to include an Adaptive Management and Mitigation Plan.

NTL No. 08-A03 Industry Site-Specific Marine Mammal Monitoring Programs. This NTL provides guidance to the lease owner/operator related to monitoring of marine mammals during the conduct of any operations on a lease. The MMS final rule published in the *Federal Register* on April 13, 2007 (Vol. 72, No. 71, pp. 18577-18585) requires OCS lease owners/operators to provide information on how they will conduct their proposed activities in a manner consistent with the provisions of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The final rule identifies environmental, monitoring, and mitigation information that must be submitted with Exploration Plans (EPs) and Development and Production Plans (DPPs). The final rule requires lease owners/operators to describe how they will mitigate the potential for takes to occur, monitor for potential takes, and report takes should they occur. The MMS operating regulations at 30 CFR 250.221(b) and 30 CFR 250.223 are requirements for EPs to include descriptions of monitoring and mitigation measures to address federally listed species and marine mammals if there is reason to believe the exploration activities may result in an incidental take. The MMS operating regulations at 30 CFR 250.252(b) and 30 CFR 250.254 are requirements for DPPs to include descriptions of monitoring and mitigation measures to address federally listed species and marine mammals if there is reason to believe the development and production activities may result in an incidental take. The NTL clarifies and interprets the requirements contained in regulations.

NTL No. 08-A04 Marine Mammal Protection Act Authorizations. This NTL provides guidance to the lease owner/operator related to the need for obtaining authorization from the NMFS and/ or the FWS pursuant to the MMPA. It is issued to clarify and interpret the requirements contained in regulations for conduct of activities in a manner consistent with the provisions of the MMPA. The MMS will not authorize activities that it believes may result in an unauthorized and, therefore, illegal incidental take.

Effectiveness of this NTL to protect Polar Bears: Notice to Lessees No. 08-A04 clarifies that MMS will not authorize or permit activities that may result in the take (as defined by the MMPA) of any marine mammal, unless the FWS has determined that any potential take that occurs incidentally to the proposed activity would result in a negligible impact to the species and the Lessee is in possession of an LOA or IHA. This insures that Lessees are advised to consult with the FWS prior to beginning any industry activities in areas that may be used by polar bears. Current Incidental Take Regulations for the Beaufort Sea require that applicants for LOAs have a plan to monitor the effects of their activities on polar bears, report any sightings of or interactions with polar bears to the FWS within 24 hours, and have a plan of cooperation in place to minimize potential impacts to subsistence hunting. Depending upon the proposed work area, applicants may also be required to conduct den surveys to identify any potential dens prior to the onset of work and to avoid any known dens by a minimum of one mile, to have plans in place to minimize bear attractants (food smells, garbage, etc.) and other mitigation measures as FWS deems necessary.

2.4. Information to Lessees. The objectives of several of the lease stipulations evaluated in the previous Arctic OCS lease sale EISs are more appropriately addressed via ITLs (see Section 2.2.1 for discussion). The proposed new ITLs are summarized below. The full text of the proposed ITLs is provided in Appendix F of the Arctic Multiple-Sale DEIS.

At-Sea Fuel Transfers. This ITL advises lessees that all at-sea fuel-transfers conducted in support of activities related to exploration and development of leases issued as a result of a proposed sale will be subject to the provisions of the following:

- Oil Pollution Act of 1990;
- Executive Order 12777: Implementation of Section 311 of the Federal Water Pollution Control Act of October 18, 1972, as Amended, and the Oil Pollution Act of 1990 (http://www.mms.gov/offshore/OilSpillProgram/Assets/PDFs/EO12777-OSP.pdf);
- Memorandum of Agreement Between the Minerals Management Service-U.S. Department of the Interior and the U.S. Coast Guard-U.S. Department of Homeland Security (MMS/USCG MOA: OCS-04 Floating Offshore Facilities) (http://www.mms.gov/MOU/PDFs/MOA-USCG04FloatingFacilities-Final.pdf); and
- U.S. Coast Guard implementing regulations at 33 CFR 156 Subpart C - Special Requirements for Lightering of Oil and Hazardous Material Cargoes (http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi).

Transportation of Hydrocarbons. This ITL advises lessees that MMS considers pipelines to be the technologically and environmentally preferred method for transportation of OCS-produced oil to shore.

Information on the Spectacled Eider and Steller's Eider. This ITL advises lessees that the spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*) are listed as threatened by the FWS and are protected by the ESA (16 U.S.C. 1531 et seq.). Lessees are advised that exploration and development and production plans submitted to MMS will be reviewed by the FWS to ensure that spectacled eider, Steller's eider, and their habitats are protected and that MMS will reconsult with FWS on the potential effects of proposed development and production activities. Lease Stipulation 2 requires lessees to adhere to the conditions of the most recent Biological Opinion issued by the FWS pertaining to post-lease activities. The ITL notifies lessees of the specific requirements under the current Biological Opinion.

ITL Information on the Spectacled Eider and Steller's Eider. Lessees are advised that the spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*) are listed as threatened by the Fish and Wildlife Service (FWS) and are protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Spectacled eiders and Steller's eiders are present in the Chukchi Sea during spring migration in May and June. Males return to the open sea in late June, while nesting females remain on the arctic coastal tundra until late August or early September, when they move to coastal areas of the Beaufort and Chukchi seas for brood-rearing. Molting eiders occur in certain offshore areas until freeze-up (typically in November). Onshore activities related to OCS exploration, development, and production during the summer months (May-September) may affect nesting spectacled eiders and Steller's eiders.

Lessees are advised that exploration and development and production plans submitted to MMS will be reviewed by the FWS to ensure that spectacled eider, Steller's eider, and their habitats are protected. For the proposed lease sales, MMS is specifically requesting an incremental Section 7 consultation with the FWS. The MMS will consult with FWS on potential effects of leasing and seismic/exploration activities.

As few details are known regarding the specific location/design of a future development, therefore that stage of activity will require further consultation with the FWS. To allow this stepwise approach, FWS must find that the leasing and seismic/exploration stage of the lease sales would not result in a jeopardy determination to either the Steller's eider or spectacled eider nor would adverse modification of spectacled eider critical habitat occur.

The FWS must also evaluate our evaluation of potential development and production that could occur as a result of leasing and exploration locating a commercially viable discovery and conclude that there is a reasonable likelihood that the entire action will not violate Section 7(a)(2) of the Endangered Species Act. Section 7(a)(2) of the Act requires that Federal agencies ensure their actions are not likely to jeopardize the continued existence of any endangered or threatened species or adversely modify designated critical habitat. Lessees are advised that future development projects arising from lease sales in the Chukchi (212 and 221) and Beaufort (209 and 217) seas will be subject to future Section 7 consultation with the FWS and a future project would not be authorized by MMS if it is likely to result in jeopardy or adverse modification of designated critical habitat as determined by FWS.

Stipulation 2 states that leases are required to adhere to the conditions of the most recent Biological Opinion issued by the FWS pertaining to post-lease activities. The following conditions apply to the Beaufort Sea.

Beaufort Sea: Measures to Minimize Effects to Spectacled and Steller's Eiders during Exploration Activities in the Beaufort Sea.

The following measures minimize the likelihood that Steller's and spectacled eiders would strike drilling structures or vessels. They also provide additional protection to eiders within other important areas, including the Ledyard Bay Critical Habitat Area, during times when eiders are present. The mitigation measures would protect ESA-listed and other marine and coastal birds during seismic activities and exploration drilling operations in the Beaufort Sea. These measures are consistent with recent Section 7 consultations for Lease Sales 186, 195, and 202 and programmatic seismic activities in the Beaufort Sea. Case-by-case exceptions require reconsultation under the ESA with the FWS.

A) General Conditions. The following conditions apply to all lease exploration and support activities.

(1) Vessels will minimize the use of high-intensity work lights, especially within the 20-m-bathymetric contour. 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.

(2) An Exploration Plan, ancillary activities, and other proposed lease activities 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, 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 U.S. Fish and Wildlife Service (FWS) does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

B) Seismic Activities. The following conditions apply to any seismic survey activities and supporting vessels and aircraft supporting those activities.

(1) No vessels associated with Beaufort Sea seismic survey activity en route to the Beaufort Sea will be permitted within the Ledyard Bay Critical Habitat Area following July 1 of each year, unless human health or safety dictates otherwise.

(2) Seismic-survey support aircraft would maintain at least a 1,500 ft (305 m) altitude over beaches, lagoons, and nearshore waters of the Beaufort Sea as much as possible. Support aircraft associated with Beaufort Sea seismic survey activities are not expected to operate over the Ledyard Bay Critical Habitat Area. If so, however, aircraft must avoid overflights across 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.

(3) Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic substance spill. If seismic-related vessels transit through the spring lead system before June 10 they may encounter concentrations of listed eiders. These vessels are required to have wildlife hazing equipment (including Breco buoys or similar equipment) pre-staged, 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, in order to ensure rapid deployment in the event of a spill.

(4) The spring lead system is defined as the Ledyard Bay Critical Habitat Area as well as the Federal OCS areas landward from an imaginary line extending from the outer corner of the Critical Habitat Area (70°20’00” N. x 164°00’00” W.) extending northeast to the southeastern-most corner of the Lease Sale 193 Sale Area (71°39’35” N. x 156°00’00” W.) and the area landward of an imaginary line drawn between Point Hope and the other outer corner of the Ledyard Bay Critical Habitat Area (69°12’00” N. x 166°13’00” W.).

C) Drilling Activities. The following conditions apply to operations conducted in support of exploratory and delineation drilling.

(1) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within or traversing the Chukchi Sea spring lead system 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 3 *Breco* buoys or similar devices) and personnel trained in its use; hazing equipment may be located on-board 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.

(2) Except for emergencies or human/navigation safety, surface vessels associated with Beaufort Sea 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.

D) Lighting Protocols. The following requirements apply to all new and existing Outer Continental Shelf oil and gas leases issued west of 146° W. longitude for activities conducted between April 15 and November 15. The MMS encourages operators to consider such measures in areas to the east of 146° W. longitude because occasional sightings of listed eiders have been made there and because such measures could reduce the potential for collisions of other, non-ESA listed migratory birds that are protected under the Migratory Bird Treaty Act.

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 would 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:

(1) Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
(2) Types of lights;
(3) Adjustment of the number and intensity of lights as needed during specific activities;
(4) Dark paint colors for selected surfaces;
(5) Low-reflecting finishes or coverings for selected surfaces; and
(6) Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational and management approaches that could be applied to their specific facility and operation 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 submit this information with an Exploration Plan when it is submitted for regulatory review and approval pursuant to 30 CFR 250.223.

The following conditions apply to the Chukchi Sea.

Chukchi Sea: Measures to minimize effects to spectacled and Steller's eiders during exploration activities in the Chukchi Sea. The following measures minimize the likelihood that Steller's and spectacled eiders would strike drilling structures or vessels. They also provide additional protection to eiders within other important areas, including the Ledyard Bay Critical Habitat Area, during times when eiders are present. The mitigation measures would protect birds listed under the Endangered Species Act ("ESA-listed") and other marine and coastal birds during seismic activities and exploration drilling operations in the Chukchi Sea. These measures are consistent with the recent Section 7 consultations for Lease Sale 193 and programmatic seismic activities in the Chukchi Sea. Case-by-case exceptions require re-consultation under the ESA with the FWS.

A) General condition. The following conditions apply to all lease exploration and support activities.

(1) Vessels will minimize the use of high-intensity work lights, especially when traversing the spring lead system. 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.

(2) An Exploration Plan, ancillary activities, and other proposed lease activities 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, 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 U.S. Fish and Wildlife Service (FWS) does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

B) Seismic Activities. The following conditions apply to any seismic survey and the supporting vessels and aircraft supporting those activities.

(1) No vessels associated with seismic survey activity, including re-supply and other related vessels, will be permitted within the Ledyard Bay Critical Habitat Area following July 1 of each year, unless human health or safety dictates otherwise.

(2) Seismic survey support aircraft must avoid overflights across the Ledyard Bay Critical Habitat Area below an altitude of 1,500 ft (450 m) above sea level (ASL) after July 1 of each year, unless human health or safety dictates otherwise. Seismic-survey support aircraft shall maintain at least a 1,500 ft (450 m) altitude over beaches, lagoons, and nearshore waters as much as possible. Designated aircraft flight routes will be established for situations when aircraft associated with seismic activity cannot maintain at least 1,500 ft ASL over the Ledyard Bay Critical Habitat Area.

(3) 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 ESA-listed eiders. These vessels are required to have wildlife hazing equipment (including Breco buoys or similar equipment) pre-staged, 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, in order to ensure rapid deployment in the event of a spill.

(4) The spring lead system is defined as the Ledyard Bay Critical Habitat Area as well as the Federal OCS areas landward from an imaginary line extending from the outer corner of the Critical Habitat Area (70°20’00” N. x 164°00’00” W.) extending northeast to the southeastern-most corner of the Lease Sale 193 Area (71°39’35” N. x 156°00’00” W.) and the area landward of an imaginary line drawn between Point Hope and the other outer corner of the Ledyard Bay Critical Habitat Area (69°12’00” N. x 166°13’00” W.).

C) Drilling Activities: The following conditions apply to operations conducted in support of exploratory and delineation drilling.

(1) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within the Spring Lead System 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 3 *Breco* buoys or similar devices) and personnel trained in its use; hazing equipment may be located on-board 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.

(2) Except for emergencies or human/navigation safety or as otherwise specified in item E (Exploratory Drilling Operations in the Ledyard Bay Critical Habitat Area) below, 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.
(3) Aircraft supporting drilling operations will avoid operating below 1,500 ft ASL over the spring lead system between April 15 and June 10 and 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 Exploration Plan. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.

D) Lighting Protocols. The following requirements apply to all activities conducted between April 15 and November 15 in the Chukchi Sea.

Drilling 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 would 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 or 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:
(1) Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
(2) Types of lights;
(3) Adjustment of the number and intensity of lights as needed during specific activities;
(4) Dark paint colors for selected surfaces;
(5) Low-reflecting finishes or coverings for selected surfaces; and
(6) Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational and management approaches that could be applied to their specific facility and operation 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 submit this information with an Exploration Plan when it is submitted for regulatory review and approval pursuant to 30 CFR 250.203.

E) Exploratory Drilling Operations in the Ledyard Bay Critical Habitat Area. The following condition applies to any exploratory and delineation drilling operations proposed to occur on leased blocks within in the Ledyard Bay Critical Habitat Area (July 1–November 15).

The drill rig and support vessels must enter the Ledyard Bay Critical Habitat Area from the northwest and proceed directly to the drill site. Support vessels will remain in close proximity to the drill rig while providing support and exit the drill rig vicinity to the northwest until out of the Critical Habitat Area. Deviations from this routing shall be reported within 24 hours to MMS.

Nothing in this ITL 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.